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It is customary to issue with the last number of each volume of ELECTRICAL WORLD AND ENGINEER an index of its contents. Such an index would have appeared as usual in the present number, but for the fact that work on it had to be dropped in order that we might give our readers promptly the full text of the important Berliner telephone decision handed down on Monday last, and consisting of some 40,000 words. The index will be published next week.

THE BERLINER DECISION.

At the end of last February Judge Brown, in the United States Circuit Court, District of Massachusetts, gave out a rescript in the case of American Bell against the National and Century Telephone companies, deciding that the latter did not infringe the Berliner patent, on a microphone transmitter. At that time, we noted duly the decision of the judge, and we now present verbatim the full text of his opinion, handed down in Boston last Monday. Realizing the importance of this matter to the telephonic community, and indeed to the electrical public at large, we issue the whole text, with all the reference cuts, in our present issue, and in spite of the difficulty of the task—there being some 40,000 words and a dozen illustrations—the decision is available without the slightest delay.

This is indeed one of the "celebrated cases" of the electrical art, and the remarkably able study by Judge Brown of the questions submitted to him constitutes a document and memoir of the first interest. We may summarize once more the main points settled, viz., that at the date of his application, June 4, 1877, Berliner had not made the invention ascribed to him and covered by the patent issued Nov. 17, 1891; that the invention in the patent is radically different from that in the application; that the invention had been previously patented by Berliner, and that Edison was the prior inventor to such an extent that his work and that of Bell rendered Berliner entirely superfluous. In other words, it is not possible to read into the Berliner patent any of Edison's work utilizing carbon. To those who know Mr. Berliner and are familiar with his extraordinary ingenuity and inventiveness, it seems strange, indeed, that his share in creating a great art can be deemed so slight and can have loomed so large on so small a basis. For the judge's careful and painstaking review of the situation, the testimony and the argument, we must refer our readers to the opinion itself, one of the most important we have ever had the honor of publishing in a long series of great verdicts on priority in electrical invention.

TROLLEY NETWORKS.

The art of electric railroading is rapidly entering upon another stage—that of systems. The beginnings of this have been seen in the largest cities where it is now the rule rather than the exception to find all the local companies massed into one financial and physical network. To what extent the promised economies in operation have been realized, is still an open question, but there is no doubt that in the matter of transfers the public has benefited hugely. The next step in this development is seen in such enterprises as those undertaken by the Everett group of financiers, whose ambitions are not limited by any given locality, but extend from town to town, and include a thousand miles of track ramifying all over a State. The modern method of three-phase transmission renders physically possible the creation of networks of this character, and it will be interesting to see what the financial results are. Such systems, even

more than little local lines, must have a vital interest for the steam roads whose passenger and freight patronage they invade. In proportion as the trunk roads combine under the influence of the "community-of-interest" principle for through traffic these trolley networks move up into the place of the old steam road, under the influence of the "interest-of-the-community" principle, for the finer and closer development of the welfare of each locality by giving it better transportation than it ever had before.

A French Pilgrimage.

We are very glad to note that our excellent French contemporary, *L'Eclairage Electrique*, through its editor, Professor Blondin, has organized a trip to the United States, so timed as to fall in with the meeting of the American Institute of Electrical Engineers at Buffalo, the date of departure from Paris being Aug. 3, and the sailing date of return being Sept. 13. Professor Blondin has laid his plans with great care, but, of course, the programme as published does not include all the provisions made here for the entertainment of our friends from abroad. As the circulars of the Institute have already shown, a round of hearty and abundant hospitality has been laid out, and we may add that the contributions toward the fund are already handsome in amount, enabling the committee to return in a liberal manner the cordial reception given to Institute members abroad last year.

To our French friends we can only say that they will be peculiarly welcome in this country, whose history is so full of the records of French valor and love of liberty, and whose political institutions rest on the same philosophical principles of broadest humanity. Nowhere is French leadership in the arts and sciences more thoroughly appreciated than on these shores; nowhere do the Gallic clearness of vision and felicity of expression find a warmer admiration than among our people, now so rapidly differentiating into a great, new composite nation of which probably the French element is unfortunately one of the smallest. In the art and science of electricity, the qualities of the French people have been displayed at their best, and our friends will be very much at home among those who have been trained in the school of Ampere and Coulomb and Arago, or have found their life work in trying to improve on the inventions of Planté, of Faure and of Gramme.

Electro-Chemical Theory of the Edison Storage Battery.

Elsewhere in this issue we print an article by Dr. E. F. Roeber, giving a theoretical discussion of the electro-chemical principles embodied in the Edison storage battery, recently described in a paper read before the American Institute of Electrical Engineers. The article furnishes an excellent example of the manner in which the modern electro-chemical theories may be applied to the consideration of storage batteries, and in this respect alone is of direct value in view of the little attention that has been given to these theories in this country, and the criticism to which they nevertheless have been subjected. Lack of information in full detail concerning the Edison battery—acquaintance with which appears at present to be confined only to those connected with Mr. Edison's laboratory—necessarily causes Dr. Roeber's article to be somewhat hypothetical in its premises, but the conclusions coincide with the claims made for the battery in at least two very important points. One of these is that the concentration of the electrolyte as a whole is not changed; and the other, that while the concentration in the neighborhood of the plates is subject to change, diffusion is necessarily more rapid in this type of battery than in the lead type.

Wanted—A Volt.

We wonder what would be the result of gathering from each of, say, fifty central stations the voltmeters by which the working pressure is regulated, and then comparing the lot. Possibly two might be found alike to a small fraction of a volt, but we should be greatly surprised if the readings of the aggregation did not cover a range of four or five volts. This, of course, assumes that the comparison is made fairly within the working range of the instruments, but that no corrections or adjustments are to be made for, say, thirty days prior to the test. We often see in the theses which bloom like flowers, in the spring, long series of measurements recorded to hundredths of a volt. Now, we do not wish to cast aspersions upon the hard-working young gentlemen who do the work, but we really wonder how many of them understand what degree of precision such a measurement implies. It means far more than estimating tenths of a division on an open scale instrument, and it really involves an exactness that is very rarely attained in working with commercial appliances. We are well aware of the excellence of American electrical measuring instruments—they have won their way to the remotest corners of the earth—but it is one thing to turn out a fine and well-cultivated instrument and a very different thing to be sure that such instruments will read alike after they have been in use for a while.

One of the most interesting and important tasks which will fall to the lot of the recently established Bureau of Standardization will be the overhauling of our present standard of electromotive force. A general scrutiny of instruments and a convenient source for exactly testing standard cells is greatly needed, and we earnestly hope the Bureau will see its way clear to an early attack upon the problem. It is a thing not only of great scientific importance, but of direct commercial importance. Fancy, for example, the amount of disputes that would easily arise if two manufacturers of incandescent lamps had working voltmeters even half a volt apart, and dealt with customers whose standards varied by a volt—and we more than half suspect that such a contingency is not exactly outside the range of probability. Verily, in these days of congresses, a congress of voltmeters would be an entertaining gathering.

Wireless Telegraphy.

In another column we print an extremely interesting article by Professor Fessenden relative to the important work in wireless telegraphy which has been done under the auspicies of the United States Weather Bureau. From time to time we have noted progress in the installation of Government wireless telegraph stations along the Atlantic Coast south of Cape Henry, which constituted the first practical application of this system on our continent, and indeed the first extended application in the world. From Professor Fessenden's article it appears that simultaneously those connected with the work have carried on a thorough experimental investigation of the phenomena involved in wireless transmission, some very important results of which are now for the first time disclosed in the article.

It is interesting to note that the investigation has resulted in discoveries which suggested modifications almost identical in principle with some which Marconi has recently introduced into his system, and which are described for the first time in his recent paper to which Professor Fessenden refers. One of these relates to a form of aerial conductor in connection with an adjustable inductance whereby the radiation from the sending conductor may be controlled and strengthened, and another to a method of tuning the sending and receiving stations. It is to be noted, however, that in each the principles experimentally established by Professor Fessenden and his assistants resulted in applications differing considerably from those of Marconi; and as the article to which this refers gives a discussion of these principles, the reader is enabled to judge as to the relative merit of the parallel applications. Moreover, later experiments

have led to the substitution of even more efficient arrangements for the attainment of the same ends.

While that part of the work of the Weather Bureau which Professor Fessenden describes in detail forms in itself a valuable contribution to the art of wireless telegraphy, the article refers to still more important results that have been attained, but which at present cannot be disclosed. These results, from the intimations given, appear to be of the highest value and of a kind that may work a revolution in the methods of wireless telegraphy. One of these consists in a method of controlling the radiating power of the sending spark, and increasing its efficiency many fold, it being stated that with the powerful radiation that may thus be obtained, transmission over the relatively short distance of 50 miles may be accomplished with apparatus of the simplest kind. Another important discovery of which the details are withheld is in connection with the radiating conductor, the height of which for ordinary transmission is thereby reduced to a few meters. Still another improvement of which the details will be eagerly awaited, relates to a method of selective signaling which is stated to obviate objections to which the latest Marconi syntonic system is subject. Altogether, the article of Professor Fessenden forms a contribution of unique importance to the subject of which it treats, and the Weather Bureau is to be congratulated upon the magnificent work which has been performed under its auspices.

TESTING LARGE TRANSFORMERS.

A very interesting article by Mr. J. S. Peck on the testing of large transformers appeared on page 1083 in last week's issue—the exigencies of "make up" having deprived it of the position of prominence that its importance called for. A number of interesting facts are brought forward. The 2250-kw transformers referred to are the largest yet constructed, and consequently it is of especial interest to observe the main facts in connection with them. The iron core weighs 6½ metric tons, or for each kilowatt of full-load activity of the transformer there is provided not quite 6½ lbs. of iron core, representing an activity per unit mass of about 150 watts per pound of core. The cyclical magnetic density is also carried up to nearly 12 kilogausses, and the total cyclic flux appears to be nearly 4 megamaxwells. The efficiency is a maximum in the neighborhood of full load, and amounts to nearly 0.987, a very convenient fraction to carry in the memory. This represents a loss of about 1.3 per cent at full load, the loss at 10 per cent of full load being only 2.7 per cent.

It is interesting to observe that the iron and copper losses are approximately equal at full load, the load of maximum efficiency, and that the eddy-current loss is half the hysteresis loss or one-third of the total iron loss. The density of current in the high-pressure and low-pressure coils is nearly equal, and the magnetic leakage is kept low by an intimate sub-division of the primary and secondary coils, there being apparently six of one set sandwiched between seven of the other. The reactance factor of the transformer is only about 2.6 from the figures given, which is very low considering that the high-pressure coils withstand 22 kilovolts normally, and are tested up to nearly 50 kilovolts effective. The full-load copper drop referred to the influence of both primary and secondary coils is about ¾ of 1 per cent, and the full-load reactance drop nearly 2 per cent. It is very interesting to notice that it takes nearly half an hour to obtain a steady reading of potential difference on the low-tension windings in multiple, and with the high-tension coils short-circuited. If the short-circuited coils were devoid of resistance, this time—already 30 minutes—would be extended indefinitely. By the same reasoning the insertion of external resistance into the circuit of the closed windings should diminish the time of attaining a sensibly steady state.

The method devised by Mr. C. F. Scott to separate the hysteresis loss from the eddy-current loss is also ingenious, and virtually consists in determining the outline of the hysteresis loop from successive measurements of the inclination of tangents at successive points along its contour. From the area of the loop so derived the hysteretic loss is computed, and the residue of the total iron loss is attributed to the eddy currents. A more common method of making this analysis is to operate the iron core at successively increasing frequencies, keeping the magnetic density in the iron constant, and observing the corresponding successive total iron losses. On the assumption that the hysteresis losses increase as the frequency, while the eddy current losses increase as its square, the two are capable of separation. The analysis in this case, however, is only capable of being correctly effected if the temperature of the core remains substantially constant throughout the range of frequency employed.

It is interesting to observe that the reason for the use of the transformers referred to is the reduction of pressure at the junction of the overhead and underground conductor systems near Buffalo, N. Y., from 22 to 11 kilovolts. This shows the importance of obtaining an insulating material for underground cables which shall be cheap and which shall at the same time be capable of withstanding a high pressure. The reduction of pressure from 22 to 11 kilovolts can certainly not be on the score of safety to person or property. The only reason that can be suggested for the reduction is to assist the subterranean cables, which, if guaranteed against the higher pressure, would have to be made much thicker and more expensive. It has, therefore, evidently been judged preferable to pay a toll in the transformers of some 2 per cent in the power transmitted to Buffalo, in addition to the extra copper loss for the lower pressure, rather than pay for the extra insulation which would sustain 22 kilovolts safely.

A paper upon the subject of subterranean cables was recently read before the British Institution of Electrical Engineers by Mr. O'Gorrman. It was therein pointed out that by reason of the geometry of a cable the electric stress brought to bear upon its insulating material was much greater at the inner than at the outer layers, and that consequently the inner layers were apt to become overstrained and to break down before the outer layers were brought to a like condition. He proposed that the layers of a cable should be so varied successively as to increase the specific inductive capacity inwards, for the purpose of reducing the internal stress at the increase of the external, and thereby tending to make the stress distribution more nearly uniform. It would seem that although this might not be capable of being accomplished in such a manner as to bring about uniform distribution, it might be attempted in some degree with advantage. There can be no doubt that a substantial improvement in the volt-resistance of subterranean cables without undue expense would tend greatly to reduce the expense of urban high-tension installations. At present if we add insulating layers on the outside of a cable, the volt-resistance does not tend to increase in anything like the proportion of the added expense in insulating material. At the present time transformers can be built for high pressures without unduly marked increase of expense for volt resistance, and the safety of the low-tension system connected therewith can be amply provided for against accidental crosses; but the heavy expense of subterranean cable insulation considerably reduces the magnitude of the pressures that can safely be employed in city limits.

Proposed Telephonic Opposition in Chicago.

An agitation is now going on in Chicago on behalf of the United Telephone, Telegraph & Electric Company, of Hyde Park, for an extension of its franchise, so as to enable it to give telephone service throughout the city, offering lower rates than those now paid to the Chicago Telephone Company. President Sabin, of the latter company, appeared last week before the committee on gas, oil and electric lights of the City Council, and opposed a wider franchise.

He said: "The prices already are as low as it is possible to make them and conduct the business at a profit, and the presence of one or more competing companies in the city would not induce us to make any lower rates. What we are now trying to do, however, is to really cut the rates by giving our subscribers a much better and more extended service. Up to now only the cream of the telephone business in Chicago has been skimmed off, and there are not one-third as many people having telephones as there would be if the system was properly developed. The present number of instruments in use is being rapidly added to, and we expect to have 60,000 in our exchanges before the year is out, and the total number in Chicago should reach 120,000. With this number of connections the subscriber to the Chicago Telephone Company will have the cheapest service in the country at its command."

Manager Bloch, of the Hyde Park Company, which is asking an extension of its franchise so it can cover the entire city, took the affirmative side of the question. He made the argument that it was the experience of all citizens where two companies were in existence that rates had been lowered so it was cheaper for the user to have two instruments in his office than one before the competition began. He read a letter from Philadelphia asserting that the telephone service had been both cheapened and improved by the starting of the rival company and that the same thing was true of Cleveland, Detroit and other cities.

For his company, if it were given a franchise, Mr. Bloch said, he would promise a rate of $85 for a single wire, double metallic telephone, and a rate of from $40 to $60 for others, against an average of $125 now existing, with a percentage of the gross receipts to be paid the city. His company desired, he said, to install residence telephones free of charge for all incoming calls, alongside of every instrument now installed, the charge to be 5 cents for every outgoing call.

"That is not a remarkably generous offer," said President Sabin. "We would be glad if we could get 2 cents for every switch we made."

President Sheerin, of the New Long Distance Telephone Company, of Indianapolis, spoke in favor of the proposed ordinance, saying that if it were passed it would allow his company to obtain an entrance to Chicago. Being an opposition concern, his company could not make any arrangement with the Chicago Telephone Company, and was unable to get any nearer to Chicago than Lafayette, Ind.

Condition of Erie Telephone.

The Eastern Audit Company has completed its examination of the Erie Telegraph & Telephone Company's treasurer's accounts in Eastern offices at Lowell and Boston, and are now at the division headquarters of the several subsidiary companies in the West engaged in checking the accounts with the treasurer's books. This work will be completed about Sept. 15, and with the physical report will form a basis upon which a plan will be devised to pay the $7,500,000 loan due Jan. 10, 1902, and arrange for the money that the company will require for the next year and determine the rate of dividends for the future.

The Erie Companies' gross earnings for the first four months of 1901 are $400,000 more than the corresponding months of last year. May's growth in subscribers, 3564, is one of the best the company has had and the 150,000 mark for total number of subscribers has now been exceeded by 144. While the policy of the new management is not to make any extraordinary canvass for subscribers all regular applicants for profitable service are receiving prompt attention. The natural annual growth should be at least 25,000, but the cost of connecting will be largely reduced from the fact that ample facilities for a large growth were provided during the past year.

The $26,300,000 valuation placed on the Erie Telephone properties by Messrs. Stone & Webster, being in their judgment an estimate of what it would cost to duplicate the property to-day, exclusive of rights of way and franchises, shows that the Erie funds have been well invested. To this sum a fair value of rights of ways and franchises, provided this could be obtained, adds $6,000,000, making the total valuation of the property $32,300,000. Nearly all of the Erie's 95,000 miles of long-distance wires are built upon rights of way purchased and owned absolutely by the company, and not on the highway, while an equal amount of exchange wire, 95,000 miles, is underground.

Exports from the United States.

Exports from the United States in the fiscal year 1901 now about to end will probably reach $1,500,000,000, the highest point ever recorded for a single year in the history of our export trade. For the 11 months ending with May, 1901, the total exports were $1,385,013,595, being double those of the corresponding period of 1889, and $100,000,000 in excess of the total for the 11 months of last year, which broke all previous records. Taking the commerce of the 11 months ending with May of various years as the basis of comparison, the figures of the Treasury Bureau of Statistics show that during the period under review our exports in 1889 amounted to $694,133,804; in 1894, to $834,636,085; in 1899, to $1,130,629,075; in 1900, to $1,285,831,125, and in the present year, as already stated, $1,385,013,595; while for the full fiscal year our total exports give promise of exceeding one and a half billion dollars, as the 11 months' figures only fall $115,000,000 short of that amount, and the monthly exportation of merchandise from the United States has exceeded $120,000,000 since March 1 of this year. The distribution of our exports during the year among the grand divisions, basing the estimate upon the percentages for 10 months already available, will be in about the following proportions: To Europe, $1,155,000,000, as against $1,040,000,000 last year; to North America, $195,000,000, as against $187,300,000 last year; to South America, $44,000,000, as compared with $38,900,000 in 1900; to Asia, $48,000,000, as against nearly $65,000,000 in 1900; to Oceania, $36,000,000, as against $43,400,000 last year, and to Africa, $26,000,000, as against $19,500,000 in the preceding year. It will be observed that the only decreases will be in our exports to Asia, where unsettled conditions in China have seriously affected trade, and to Oceania, from which Hawaii has been omitted as a foreign country since its organization as a territory of the United States.

Crowding Trolley Cars.

The New York aldermen have postponed for a time the consideration of an ordinance penalizing on the part of passenger and conductor the standing up in the aisles of open trolley cars. The universal opinion is that the cars run as closely together as possible, and that passengers will never consent to wait for an "empty seat that never comes." The New York *Evening Post* says sensibly on this subject: When a hundred people who can get carried in a car after a fashion are confronted with a law forbidding more than 50 to board it, the law will have to give way. To attempt to enforce it would lead to the most desperate struggles among passengers, and the feebler among them would suffer severely. The conductors would be powerless to enforce such an ordinance, and even the police would be helpless. To arrest the conductors for failing to do the impossible would not promote the rapid movement of the cars, and it would be foolish to suppose that the arrest of passengers would be sustained by public opinion. We have enough laws that are not enforced now on the statute book, and it is demoralizing to increase the number.

Wisconsin University Trade School.

The summer school for apprentices and artisans of the University of Wisconsin will begin on July 1, ending Aug. 9. This school has been established for the benefit of mechanics, superintendents of electrical plants and for young men who wish to qualify themselves for these callings. The course in applied electricity covers the management and testing of electrical machinery, the use of electrical measuring instruments, electric wiring, meters, transformers, lighting, telephone service, primary and storage batteries, central station records, elementary theory of alternating currents and their applications, electroplating and electrotyping. Only part of these courses can be taken during one summer.

Paper Making by Electricity at Millinocket, Maine.

BY ALTON D. ADAMS.

THE largest paper mill in the world has made a unique advance by the distribution of electric power for that industry at Millinocket, Maine. In the works of the Great Northern Paper Company, at that place, the long and heavy lines of shafting common in paper making plants, are replaced by electric generators, circuits and motors.

One of the important problems in great factories is the distribution of power from the prime movers to the machines that work directly on the product. The high first cost and subsequent low efficiency of extensive shafting equipments are well known. In many cases such efficiency is hardly more than 25 per cent, and it seldom rises above 50 per cent on long lines. It is now common practice in numerous branches of manufacture to connect electric generators direct to steam engines or waterwheels, and to distribute the power to electric motors that drive either individual machines or short lines of shafting. In this way the main costs and losses of shafting are avoided, and a degree of flexibility is obtained that would not otherwise be possible. The influence of this practice on the costs of manufacture obviously increases with the ratio of power consumption to the value of the product turned out.

In paper making, and especially in the manufacture of paper from wood, the required power is very large compared with the cost of the output. In spite of this fact, conservative forces in the paper-making industry have generally held to the old method of power distribution by shafting. It is therefore of special interest that the greatest paper mill in the world should be also the first of importance to adopt electrical distribution for its machinery.

The mill at Millinocket is devoted to the manufacture of newspaper stock from wood. This process involves the reduction of the wood to pulp by grinding, and the subsequent passage of the pulp through a variety of processes to obtain the finished product. A distinction between the grinding and the subsequent operations is here pointed out, because the reduction of the wood to pulp is done in a comparatively small space, but yet takes much more power than do all of the subsequent processes put together. These facts have an important bearing on the extent to which electric distribution of power in a mill can be applied with advantage to paper making of this class.

In this Millinocket plant, both steam and water power are used, though the water-power alone is abundant. To furnish steam, 12 Cahall boilers, eight set to burn coal and four set to burn wood refuse, have been provided with an aggregate rating of 4600 horse-power. Steam from these boilers is mostly consumed to heat the pulp digesters, the paper machines, and in general heating of the mill. As steam loses but little of its heating value in engines, they have been provided to furnish power for the paper machines, the exhaust going into the paper machines for heating after it leaves the engines. As steam power drives only the paper machines, and has no connection with the electric equipment, this explanation of its use is all that need be said concerning it here.

Water furnishes the great bulk of the power used in the plant of the Great Northern Paper Company. This power is all developed in turbines of the Rodney Hunt make. All of the water-power here employed may be divided into two parts, that used to drive the pulp grinding machines, and that which operates the electric generators. Except the paper machines driven by steam power and the grinding machines by water power direct, the entire plant is operated by energy from the electric generators.

This paper mill is located on the bank of the river known as the Millinocket Stream, a tributary of the West Branch of the Penobscot, which joins it some miles below the mill. About one mile from the site of the paper mill flows the West Branch of the Penobscot at an elevation of 110 ft. above the surface of the Millinocket Stream.

This difference of elevation between the two rivers is accounted for by a fall of over 100 ft. in the West Branch of the Penobscot before it is joined by the Millinocket Stream. The Great Northern Paper Company has constructed a dam at the head of these falls and leads the water desired for power through a canal to the mill on the bank of the Millinocket Stream. By means of the dam the water in the West Branch of the Penobscot is raised in level about 10 ft., and a large storage reservoir created between the river and the mill. The West Branch of the Penobscot drains 1800 square miles of forest land, and furnishes ample water power for the mill at all times.

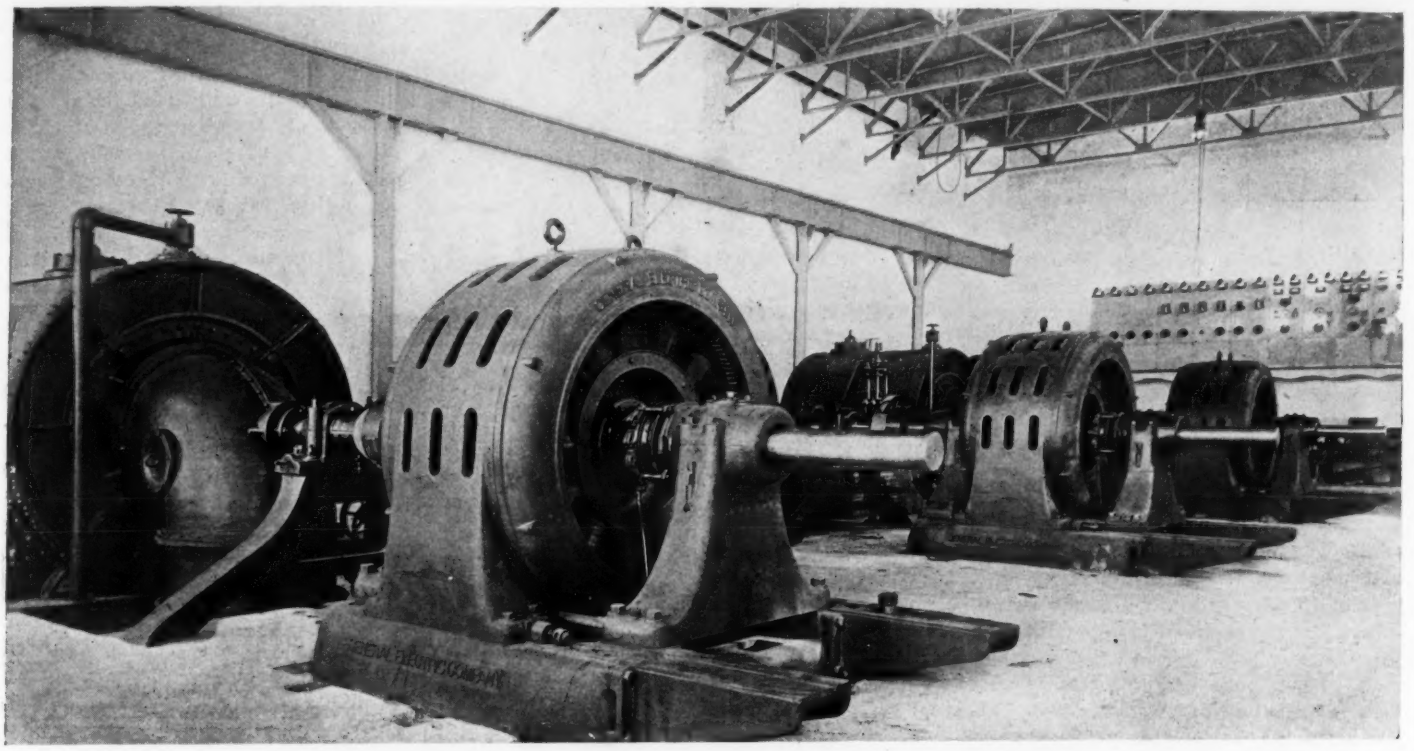


FIG. 1.—GENERATORS AND SWITCHBOARD IN PAPER MILL, MILLINOCKET, ME.

The grinder room is moderate in dimensions, only 211 by 187 ft., but its machinery is intended to consume 23,400 horse-power.

Grinders to the number of 72 are provided for in the grinder room, and 48 of these are already in position. The grinders are arranged in six rows of 12 each, and a pair of turbine wheels drives each row of grinders direct connected on their extended shaft. Each pair of turbine wheels driving a row of grinders are 57 inches in diameter, and competent to develop 3900 horse-power, giving a total capacity of 23,400 horse-power for the six pairs of wheels. Particular attention is called to the conditions under which the grinders are driven, as they are so close to the wheels that the problem of power distribution is practically eliminated.

From the reservoir on the same level as the West Branch of the

Penobscot, and between that river and the paper mill, four steel penstocks, each 10 ft. in diameter, are laid to the grinder rooms. Each of these four penstocks connects directly, and only with one of the four pairs of wheels, driving a line of 12 grinders. By this construction the water may be shut off at the reservoir head gates from any one penstock, thus stopping one line of grinders without any influence on the others. As soon as the other two rows of grinders for which room has been provided are in position, two more penstocks will be laid from the head gates at the reservoir to the wheels for the grinders. Each of these penstocks is 1000 ft. in length.

This arrangement of separate penstocks and wheels for the several rows of grinders is of special interest because it illustrates the policy

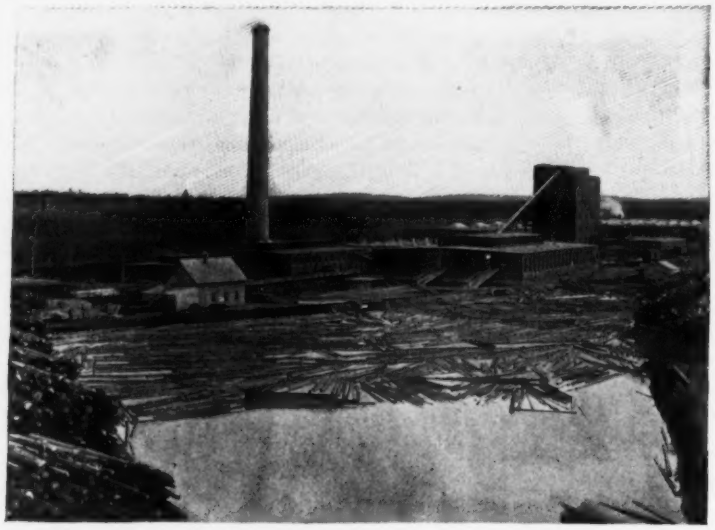


FIG. 2.—GENERAL VIEW OF MILL.

that has governed the application of power throughout the entire plant.

The important aim in the design of the Millinocket mill was to secure the most direct movement of stock through the several departments, and to make each independent in its operation, in order to ensure a low cost of manufacture. As the plant covers most of an area 465 by 975 ft., with a large number of departments on different levels, the flexibility and arrangement desired made many power units necessary. Such a division of generating units might be obtained with separate waterwheels and penstocks, but this equipment with its attendant construction would be very expensive. Long lines of very heavy shafting might have been used to transmit power throughout the plant, as in the ordinary paper mill construction. This would not only have been expensive, but would not have given the required flexibility. After consideration of all available plans, electrical distribution of power throughout, except for paper machines and grinders, was decided on.

To supply water for wheels to drive electric generators, a fifth penstock, 11 ft. in diameter, was laid from the head gates at the reservoir to the electric generator room. This room is next to that in which the grinders are located, and is located about 714 ft. from the more distant end of the plant. Three alternating generators, each three-phase, with a capacity of 1000 kilowatts, at 600 volts and 400 r. p. m., are located in this room. Each generator is driven direct by a pair of 36-inch special turbine wheels, competent to develop 1500 horse-power at the speed named.

Two exciters are operated for these generators, each exciter having a capacity of 60 kilowatts, direct driven by a special 24-inch wheel, at 600 r. p. m. The shafts of these 24-inch wheels are extended on the sides opposite to the exciters, and terminate in friction rolls, which can be connected to drive rotary fire pumps when desired. The pair of 36-inch wheels for each of the main generators is provided with a Lombard governor. All of the turbine wheels were made by the Rodney Hunt Machine Company. A 10-ton traveling crane is provided in the generator room that can be brought directly over any of the machine units. At one end of the room, on a gallery built for the purpose, is the switchboard that controls the entire electric system.

On the panels of the board are located indicating instruments, and the handles of switches for the several generators, the various circuits and the regulating rheostats. The space beneath the gallery is enclosed by brick walls, with a door at each end, and in this space, which is about 32 ft. long, 8.25 ft. wide and 9 ft. high, are located the main working parts of the switchboard, including the oil switches. Circuits are arranged to connect the board with single large motors or groups of small motors in the different departments of the mill so that the power consumed by each may be indicated and recorded. Connections between the generators, exciters and switchboard are made by wires and cables laid in tile conduits beneath the floor of the generator room.

While most of the energy from the electric plant is used to drive motors, a very considerable amount is devoted to electric lighting, which is the only method of illumination provided for. About 750 incandescent and 92 enclosed-arc lamps are used to light the entire plant, and these are all operated by the alternating generators. The incandescent lamps used require about 120 volts, and transformers are consequently located at suitable points about the mill to reduce the line pressure from about 600 volts and limit the lengths of the lamp circuits to short distances. The arc as well as the incandescent lamps are operated on these secondary lines from transformers. Circuits that supply transformers for lamps are not connected to motors with heavy and fluctuating loads, because of the variations that would result in the light of lamps.

Electric wiring throughout the mill is of the open or exposed type, and the kind of insulation used is varied to suit the conditions in the several departments. In that part of the mill where acid is used to treat the wood pulp for the production of sulphite, lead-covered wires are run, in order to protect the insulation from the acid fumes. In many other places where the ceilings and air are wet, rubber-covered wire is employed. Much of the wiring about the plant is in dry places, and is covered with simply fireproof insulation. As the buildings are constructed entirely of brick, tile, stone, steel and concrete, and the electric circuits are erected with porcelain supports, they come in contact with nothing that can be set on fire.

The most unique feature in the equipment of this paper mill is the use of electric motors to drive all departments, except the grinder room and the paper machines. The equipment includes motors of both the synchronous and induction types with speeds, capacities and methods of connection as follows: One 300-hp, 400 r. p. m. synchronous motor, connected by rope drive; two 300-hp, 400 r. p. m. synchronous motor, belted; three 300-hp, 480 r. p. m. induction mtors, belted; one 250-hp, 480 r. p. m. induc-

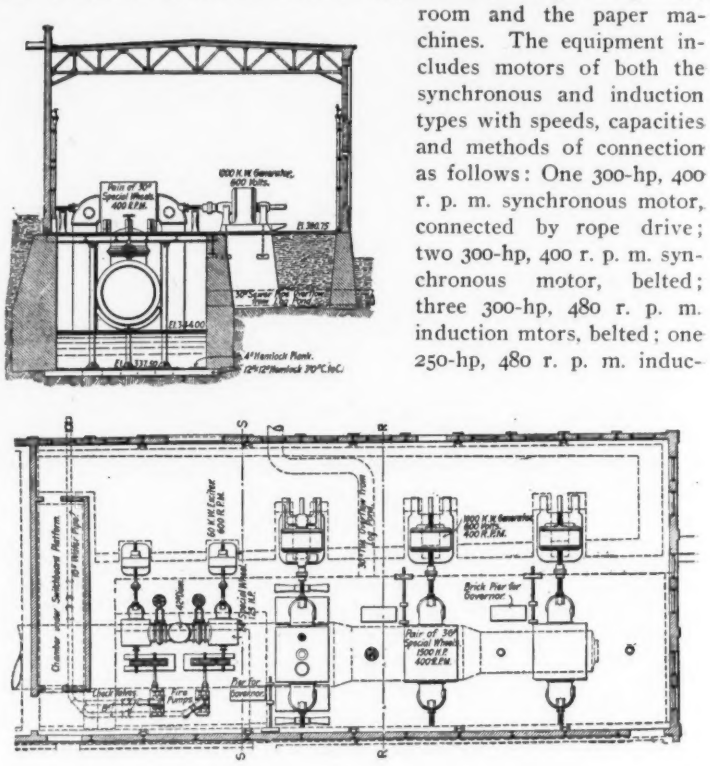


FIG. 3.—SECTION AND PLAN OF STATION.

tion motor, with rope drive; four 250-hp, 480 r. p. m. induction motors, belt connected; one 200-hp, 480 r. p. m. induction motor, belted; one 100-hp, 600 r. p. m. induction motor, belted; one 75-hp, 800 r. p. m. induction motor, belted; three 50-hp, 800 r. p. m. induction motors, belted; three 30-hp, 800 r. p. m. induction motors, belted; one 10-hp, 1200 r. p. m. induction motor, belted; three 5-hp, 1200 r. p. m. induction motors, belted.

The aggregate nominal capacity of these motors is 3690 horsepower, though they are, of course, capable of temporary overloads. It was found above that the grinder room alone has four pairs of

wheels that develop 3900 horse-power each at the present time, or a total of 14,600 horse-power. But this large amount of power is consumed in the limited space of 211 by 187 ft., while the motors deliver their power over an area 975 by 465 ft. At 60 watts each the 750 incandescent lamps require 45 kilowatts, and at 500 watts each the 90 enclosed-arc lamps also consume 45 kilowatts, making a total of 90 kilowatts, or 120 horse-power for lighting. Together with the 3690 horse-power for the motors at normal output, the total load on the electric generators is 3810 horse-power. The three generators have a combined rating of 3000 kilowatts, or 4000 horse-power, so that the present load is less than their rated capacity. As the average motor load is naturally less than the rated capacity, the present generators may be sufficient when the grinder room receives its full equipment of 24 more grinders, and the work in other departments demands more motors.

To indicate the diversity and kinds of work done by the motors, the following are mentioned. The sulphate screen, wet machines, an 18-inch centrifugal pump, and the screen scrapers are operated by one 300-hp synchronous motor. Each of two 300-hp synchronous motors, and each of two 300-hp induction motors drives four beating engines, two refining engines and two stuff chests. One 24-inch centrifugal stock pump, one 18-inch centrifugal white water pump, a small vacuum pump and sliver and millard screens, from the load of another 300-hp induction motor. One 8-inch special white water pump, two 8-inch centrifugal stock pumps and two agitator shafts are driven by an induction motor of 250 horse-power. An induction motor of 250 horse-power drives the ground wood screens, 27 Decker wet machines, 6 felt wet machines, 1 elevator and screen scrapers. Two conveyors, three chippers, a rechipper, two chip crushers and a rotary chip screen are all driven by another 250-hp induction motor. Two induction motors of 250 horse-power each do the work of driving two loghauls, four sets of live rolls, four swing saws, a 4-ft. wood saw, with platform conveyor, two chain conveyors, four splitters and four waste conveyors. The entire acid plant, including four lime tanks, two absorbing tanks, four large vacuum pumps, two small lime pumps, and a small acid pump, are driven by one 250-hp induction motor. A 100-hp induction motor is required for an 8-inch centrifugal acid pump. A special 8-inch centrifugal stock pump is driven by the 75-hp induction motor. All of the following motors are of the induction type. A 50-hp motor is employed to drive a 6-inch centrifugal pump for washing filters. Another 50-hp motor drives the machine shops. Two chain conveyors to carry blocks to the grinder room are operated by a third 50-hp motor. Of three 30-hp motors one drives the belt conveyor for chips, another operates the belt conveyor that takes waste wood to the boiler house, and the third is required for the calender roll grinder. The 10-hp motor runs an elevator. Each of three 5-hp motors operates a section of the cleaners for the economizers.

It is evident that the 25 motors here mentioned allow a wide variation in the rate at which operations in the several parts of the plant shall be carried on.

Each motor is provided with a switch near its point of use so as to be readily started or stopped at any time. It is stated by those in charge of the plant that the use of electric motors for individual machines and for separate departments makes it practicable to determine the power consumed in the various operations of paper making much more accurately than has previously been the case. It is worthy of note that the alternating, three-phase system is used throughout this plant, though the distances are so short that no high voltage is necessary. While the operation of direct-current machines at their commutators is now nearly perfect, it is evident that the use of such machines for the plant here would have introduced an element of wear and possible trouble that is now absent. It seems certain that this innovation in the distribution of power at paper mills, with its many advantages, will be quickly imitated, and that electrical equipment will prove as popular for this line of work as it is in other industries.

The entire contract for the above electrical plant was let to the General Electric Company. The electric generators were first started Oct. 27, 1900, the lamps Oct. 28, the motors Oct. 29, and the entire equipment has operated in a most satisfactory manner ever since.

For the facts stated in this article especial thanks are extended to Mr. H. S. Ferguson and Mr. J. W. Tower, the engineers to whom the successful design and operation of the plant of the Great Northern Paper Company, are due. By the operations of this company a thriving town has taken the place of scrub oaks and scanty pines within a period of less than two years.

Wireless Telegraphy.

By REGINALD A. FESSENDEN.

EVEN an experimenter working along similar lines and finding a considerable number of devices which he had considered as peculiarly his own, described in the paper, may be pardoned for feeling a considerable degree of pleasure in reading the admirable communication recently made by Mr. Marconi to the Society of Arts. Mr. Marconi is certainly to be congratulated not only upon the practical results which he has achieved, but also upon the beauty of the methods employed. It is most certainly apparent that his method has now passed from the original crude stage to a practical and commercial one.

It may be of interest to compare the results, at least some of them (for it would be inadvisable at present to publish more than a part), obtained on this side of the water by the United States Weather Bureau. These experiments were commenced under the direction of the chief of the Weather Bureau, Professor Moore, in January, 1900. Under his direction and with his approbation the subject was investigated from the beginning, with a view first to finding out definitely the nature of the phenomena, and then devising means for utilizing the forces to best advantage. First will be described a number of cases in which the work of Mr. Marconi and that of the Weather Bureau has gone along parallel lines; secondly, the differences between the methods and results obtained so far as published, and, lastly, an indication of work done by the Weather Bureau which has not been, so far as is known at present, duplicated. Naturally, on account of commercial considerations it will not be possible to go into details so much as might be desired, and for the present this deficiency must be excused.

The first point in which parallel results have been obtained is that concerned with the employment of larger capacities, more especially in the form of cylinders. Mr. Marconi describes the use of concentric cylinders, the inner one connected through a self-inductance to ground, and explains very clearly that in the case of wire conductors the electrical oscillations rapidly die away, and that with greater capacity we have a more persistent vibrator.

The following quotation from one of the patent applications of the Weather Bureau experimenters will show that in this respect the same result has been reached, "The employment of simple wires having small capacity as sending conductors is objectionable for the reason that the radiation is so rapid that there are very few oscillations in each discharge, and hence the inductive rise in voltage at the receiving station cannot attain sufficient value to permit of the use of inductive devices for arresting the potential at such station. By the employment of conductors having large capacity at the sending station, and by properly proportioning the self-inductance and resistance, the radiation from the conductor can be so controlled that there will be a large number of oscillations; for example, 50 or more at each total discharge. In other words, the discharge is so controlled that only a small fraction of the total energy is radiated at each oscillation. By thus extending the period of radiation opportunity is afforded for the inductive voltage at the receiving end to rise to its full value. By increasing the number of oscillations for each total discharge from the sending conductor, and by adjusting the receiving system so that its natural periodicity corresponds, or approximately so, to the period of the electromagnetic waves, the distance of travel of the waves is not solely dependent upon the heights of the sending and receiving conductors as has heretofore been held." And the corresponding claim:

"In a system of wireless telegraphy a conductor adapted to radiate electromagnetic waves having its capacity, inductance and resistance so proportioned that only a relatively small fraction of the energy of the large conductor is radiated during a single oscillation, thereby preventing rapid vibrating in oscillations substantially as set forth."

As regards the details by which this is accomplished, Mr. Marconi uses two concentric cylinders, the inner one having an inductance connected with it. The object of the inductance is not fully described, but Mr. Marconi lays great stress upon it. According to the writer's experiments, the object of this inductance is three-fold. In the first place, as Mr. Marconi explains, it gives a difference in phase; secondly, it is only the outer conductor which radiates, and this radiates just as a simple cylinder of the same size would radiate if used as an ordinary vertical conductor, but for the fact that the oscillations are more persistent when the inductance is put in. For the formula for

logarithmetic decrement contains the power, $\frac{R}{L}$, and hence we can decrease the decrement, i. e., render the oscillation more prolonged by increasing *L*. Also the two concentric cylinders act as a condenser, and this in combination with the inductance means that we really are shunting the spark-gap with a synchronous circuit of larger capacity, as was suggested by Dr. Pupin in his discussion of wireless telegraphy before the American Institute of Electrical Engineers.

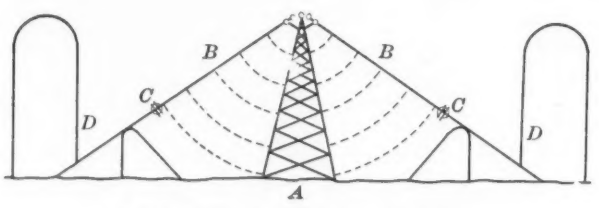
In this respect the work has not been parallel, for while the patent application and the drawings described inductances used in this manner, the same effect has been obtained, not by increasing the denominator, but by decreasing the numerator of the fraction $\frac{R}{L}$ This has been done in three different ways which will be described at a later date. The advantage of this method is that whilst when we increase the denominator we decrease the period and also decrease the total amount of energy radiated per oscillation, if we decrease the numerator we keep the amount of energy radiated the same and do not change the period, while at the same time we make the logarithmetic decrement just as small as can be obtained with the inductance. This means a greater sending power with a given height.

Another line in which parallel results have been obtained is in the tuning of the secondary of the receiving transformer. Mr. Marconi shows clearly the necessity of this, and we may compare this with the following statement from another of the patent applications:

"It has heretofore been impossible to make the receivers respond solely to waves of one periodicity, as other periodicities, if above a certain power, will affect the receivers. By constructing the second conductor so that the oscillations for each total discharge are increased, and by employing at the receiving station two or more tuned circuits, a very perfect resonance or tuning between the stations can be obtained. With one tuned circuit at the receiving station and with conductors permitting a rapid radiation at the sending station, electrostatic and hysteresis effects become very prominent, and the great self-inductance desirable for sharp resonance cannot be attained. By employing two tuned circuits, one connected to the receiving conductor and the other secondary to the first, the electrical effect in the secondary will occur only when the resonance is very sharp." And the corresponding claim, "In a system of wireless telegraphy a sending conductor in combination with a prime conductor, including the receiving conductor and one or more secondary circuits controlled by the primary circuit; a transmitting device included in the last circuit of the series, the several circuits being tuned to correspond to the period of the second conductor substantially as set forth."

Here, however, there is another difference. Mr. Marconi makes the secondary of his coil equal to the height of the sending conductor. The writer makes it equal to twice the height of the sending conductor. Two explanations of this are possible: First, that Mr. Marconi uses the secondary wound in such a manner that the wire really has a longer natural period than if it were straight; secondly, that he is really working with the first overtone. I have found that the overtones are very pronounced, more especially when the spark length is slightly longer than that generally used. There may be some other cause not at present known, but all the writer's experiments seem to show that the wave length is really four times the length of the vertical conductor and not twice.

Another difference consists in the form of the radiating conductor. Mr. Marconi uses concentric cylinders, but in the Weather Bureau experiments simple cylinders were at first used. Later these were replaced by conductors of the form shown in the accompanying sketch, in which *A* is a tower, *BB* are cables insulated from



FORM OF EXPERIMENTAL CONDUCTORS.

the tower at its top, *CC* are insulated strain insulators, and *DD* ropes boiled in an insulating compound. The spark or other apparatus is placed at the top of the tower and the waves go out, as shown by the dotted lines. This kind was later superseded by a third form, and this kind by a fourth, which will be referred to later.

Another case in which parallel work was done is that in which a Thomson high-frequency coil (commonly called a Tesla coil, but in reality first brought out in its present form by Professor Elihu Thomson) was used. Unfortunately, however, some other modifications are used with it, which, as the patents have not been granted, it will be impossible to describe at present. The writer's experiments show plainly that Mr. Marconi's remarks on Professor Slaby's work are justified, and that much better results can be obtained by the Marconi methods.

Lastly, with respect to the general direction in which the work of the Weather Bureau has progressed. In the first place, it has been found possible in several ways to get over the old difficulty which troubled Hertz, and later experimenters, i. e., that when the spark length was increased beyond a certain length the discharge become no longer oscillatory. An electrical device was invented which, on being applied directly to the sending wire, measured directly the amount of energy radiated. A curve was then plotted, showing the relation between spark length and energy radiated, and it was found that the curve gave a sharp bend with a spark about one inch in length, and no further increase of radiation could be obtained. Different kinds of coils with different primaries and secondaries, different methods of producing the voltage, different kinds of gases and fluid insulators in which the balls were immersed, and different kinds of arrangements of the terminals were tried, but all without success. But finally the solution was found, with the result that with the later apparatus an amount of radiation 16 times as great as that got with the ordinary 12-inch coil and 1-inch spark was obtained. This means, of course, greater sending distance, and it may be mentioned here that transmission without the use of transformers, inductive devices, cylinders or any other apparatus for raising the voltage, has been accomplished over a distance of 50 miles without using more than a fraction of the available energy. The same result was also accomplished in two other ways.

The question of high conductors has proved a rather serious one, because, as Mr. Marconi has pointed out, if we use large surface conductors, though they may be short, yet they are objectionable on account of the wind pressure. Means for overcoming this are described in some of the patent applications, but the method was finally abandoned because means have been found by which a conductor only one meter high can be made to radiate as much energy and of the same period as a conductor 100 meters high. Another difference again has been the fact that it has been found necessary to differentiate in form between the receiving and sending conductors, i. e., to have the receiving conductor with more self-inductance and less capacity than the sending conductor.

Other work done by the Weather Bureau has been along the line of producing a non-interfering system. The admirable and beautiful work of Mr. Marconi has resulted in a system by which within certain limits messages can be sent without interference. But one great objection has been found in the Weather Bureau experiments to this method, although it is described in some of the earlier patents of the Weather Bureau experimenters. That is, that while it is no doubt possible, under certain conditions, to send and receive individual messages, yet by connecting two brass semi-circles to a motor revolving at several thousand revolutions per minute, it is possible to make what may be called an electrical siren which runs up and down a scale of seven or eight octaves several thousand times a minute, and which, as at some period of the scale it gives a note corresponding to any given syntonized receiver, is consequently able to stop all communication, when used in conjunction with the apparatus for strengthening the radiation, within a radius of 500 miles or so. Consequently this method has been superseded by several other methods which permits of selective signaling, no matter how strong the interfering radiator may be or how close it may be, even approaching the interfering radiator within a few feet producing absolutely no effect.

The parallel manner in which a considerable part of this work has been done may possibly be taken as evidence of the fact that the matter has now got down to a sound scientific base. Mr. Marconi and his eminent colaborateur, Dr. Fleming, are certainly to be congratulated on the results they have so far achieved, and no one joins more heartily in wishing them the best of success than the writer. The future of wireless telegraphy in their hands is certainly assured, and it cannot be many years before Mr. Marconi will see the great system which he was the first to see the points of and to put in practical form, in as universal use as our present methods of telegraphy.

On Theoretical Concentration Changes in the New Edison Battery.

BY E. F. ROEBER, PH.D.

IN this article I intend to draw some conclusions from the modern theory of the electrolysis of aqueous solutions regarding the working of the new Edison battery. As I have had no opportunity of making any experiments with the cell I have been unable either to confirm or to refute my results. It seems to me, however, quite legitimate and interesting to discuss the processes in the new Edison cell from the point of view of a theory which, in the opinion of many, gives a good description and explanation of a large number of electro-chemical facts.

The following research refers not only to the Edison nickel-iron cell, but to the general type of cell of which the new Edison cell is a special example. This general type may be characterized as a cell in which the chemical process during charge and discharge consists in the transport of oxygen from one plate to the other, while the chemical composition and the total concentration of the electrolyte (i. e., the ratio of the total number of molecules of the dissolved electrolyte to the total number of water molecules) remain unchanged.

I have defined the "total concentration" of the electrolyte in this exact way, to avoid a misunderstanding. This misunderstanding would be to assume that the electrolyte is not changed at all. From all electro-chemical facts, however, we know that an electrolyte always undergoes concentration changes during electrolysis. If the "total concentration," as defined above, does not change, there are nevertheless concentration changes in the different parts of the electrolyte; either the concentration of the solution increases at the anode and decreases at the cathode, or it decreases at the anode and increases at the cathode. It will be shown presently that Hittorf's theory leads to such conclusions for the Edison battery, and the numerical data will be given. These changes of concentration, however, must have some influence upon the practical working of the Edison cell. This may be concluded from the analogy with the lead accumulator, where the concentration changes in the porous plates are of the greatest importance for the behavior of the battery.

It may be of advantage to give a brief review of a few characteristic examples of the general type of the Edison cell.

Silver-Copper Battery.—This somewhat expensive, but theoretically very interesting battery has been devised by Mr. E. W. Jungner (German Patent 110,210, March 31, 1899; see also *Centralblatt f. Accum. u. Elementenkunde,* April 15, 1900, and *Elektrochemische Zeitschrift,* August, 1900). The positive plate is peroxyde of silver in a finely divided state, the negative plate copper in a finely divided state, the electrolyte is an aqueous solution of potassium hydroxyde. The discharge consists of two steps, the chemical reactions during these two steps being represented respectively by the equations

$$Ag_2O_2 + 2\,Cu = Ag_2O + Cu_2O$$

and

$$Ag_2O + 2\,Cu = Ag_2 + Cu_2O$$

The e. m. f. of the first step corresponds to the difference between the formation heats of Ag_2O_2 (from Ag_2O and O) and Cu_2O (from $2\,Cu$ and O). The e. m. f. of the second step corresponds to the difference between the formation heats of Ag_2O (from Ag_2 and O) and Cu_2O (from $2\,Cu$ and O).

Copper-Cadmium Cell.—This is an older cell of Mr. Edison, which was described in the ELECTRICAL WORLD AND ENGINEER, April 6, 1901.

Nickel-Iron Cell.—This is the new cell of Mr. Edison, described in Dr. A. E. Kennelly's Institute paper (ELECTRICAL WORLD AND ENGINEER, May 25, 1901). The positive plate is a "compound of nickel" in a finely divided state, the negative plate is a "compound of iron" in a finely divided state, the electrolyte is an aqueous solution of potassium hydroxide. If the "compound of iron" at the beginning of the discharge is expressed by Fe and the "compound of nickel" by NiO_2—where Fe and NiO_2 may not represent the exact chemical composition, but are simply convenient signs—the chemical action during discharge is given by the formula

$$NiO_2 + Fe = NiO + FeO \qquad (1)$$

It will be seen that in all examples of this type of battery during the discharge the positive plate is reduced from a higher state of oxidation to a lower state of oxidation, and the negative plate is oxidized from a lower state of oxidation to a higher state of oxidation, while the chemical composition of the electrolyte is not changed. The electrolyte in all these batteries is an aqueous solution of potassium hydroxide, or of sodium hydroxide, or, generally speaking, of "any metallic hydrate soluble in water and having a metallic radicle which decomposes water" (Jungner).

In the discussion which followed Dr. Kennelly's paper, Mr. C. J. Reed has pointed out the following features which make this general type of battery extremely interesting. The capacity of the cell is not limited by the quantity of the electrolyte. Very little electrolyte is therefore required in it, the electrodes can be brought near together, and the resistance and the weight are thereby diminished. Further, the resistance of this type of cell will tend to remain constant to a far greater degree than that of the lead accumulator. In the latter lead sulphate is formed during discharge, which is a far poorer conductor than the oxides in the Edison cell. Finally, Mr. Reed pointed out that with this type of cell there is a possibility to charge it by a non-electric method, i. e., to reduce the one plate and oxidize the other plate outside of the jar by a non-electric method, so that this type of battery might become an instrument for transforming heat and chemical energy from other sources into electrical energy—an instrument for an indirect process of getting electrical energy, possibly out of carbon, and perhaps a very economical process.

Now, the question arises: What is the action of the electrolyte during charge and discharge? What is the mechanism by which the electrolyte transports oxygen from one plate to the other plate? To discuss this question, I will assume as fundamental hypothesis the so-called "theory of electrolytic dissociation." According to this theory, there is in an aqueous solution of KOH a certain number of KOH molecules split up into K ions and OH ions, each univalent gram ion K being charged with 96,540 coulombs of positive electricity and each univalent gram ion OH being charged with 96,540 coulombs of negative electricity; 1 gram ion means so many grams as the equivalent weight indicates. The degree of ionization (i. e., the ratio of the number of molecules KOH, split up into ions, to the total number of molecules KOH, dissolved in the water), depends upon the concentration and may be determined by Arrhenius' method by a measurement of the electric conductivity. Only the charged ions K and OH are active in the conduction of electricity through the electrolyte. The water molecules and the neutral KOH molecules which are not split up into ions, are inactive. When 96,540 ampere-seconds flow through the electrolyte, 1 positive gram ion is set free at the cathode and gives off its charge and 1 negative gram ion is set free at the anode and gives off its charge so that indeed 96,540 coulombs of positive electricity have been transported from the anode to the cathode; or when 1 ampere-second flows through the electrolyte, $\frac{1}{96,540} = 0.0000104$ positive gram ions and 0.0000104 negative gram ions are set free. This is nothing else than Faraday's law, which states that 0.0000104 gram equivalents KOH are decomposed by 1 ampere-second.

If we apply this scheme to the new Edison battery we find that when in discharging it gives off $2 \times 96,540$ ampere-seconds, two gram ions OH become free at the Fe plate and two gram ions K at the NiO_2 plate. The chemical reactions at each plate may then be represented by the following formulas:

$$Fe + 2\,OH = FeO + H_2O \qquad (2)$$

and

$$NiO_2 + 2\,K + H_2O = NiO + 2\,KOH \qquad (3)$$

The summation of these two formulas gives, of course, again equation (1), but these two formulas show more than equation (1). It will be seen from (2) and (3) that in the dischrage of $2 \times 96,540$ ampere-seconds the chemical reactions at the electrodes cause the formation of one molecule of water at the Fe plate, and the consumption of one molecule of water at the NiO_2 plate, so that the solution at the Fe plate thereby becomes less concentrated, and that at the NiO_2 plate more concentrated.

For the chemical reactions (2) and (3) we assumed that 2 ions OH and 2 ions K are set free at the iron and nickel plate, respectively. How did they come there? The theory assumes that they have come there by migration, that all positive K ions have migrated with a certain speed in the direction of the current, and all OH ions with a certain speed in the opposite direction. The question of the relative speeds of the two kinds of ions was first discussed by Hittorf. Let us assume we have at the beginning of the electrolysis m ions K and m ions OH in the solution. To get a convenient me-

chanical illustration of Hittorf's views, let us think that the m ions K are arranged one after the other in a straight line between the iron and nickel plates, and the m ions $O\ H$ one after the other also in a straight line at the side of the K ions. It will be seen that each positive ion has a negative ion at its side, so to speak, as a partner. In order to compare the relative speeds of the two kinds, we divide the lines of ions into two parts by an imaginary plane, normal to the direction of the current, and ask: How many positive K ions cross this plane in one direction and how many negative $O\ H$ ions cross this plane at the same time in the opposite direction?

The number of K ions set free by a given number of ampere-seconds at the cathode may be n, the number of $O\ H$ ions set free at the anode, must then also be n. From this alone we cannot say how many K and how many $O\ H$ ions have crossed our imaginary plane in opposite directions. For we might assume that only the K ions traveled and the $O\ H$ ions remained at their places; if n K ions and no $O\ H$ ion cross the imaginary plane, every K ion passes along n $O\ H$ ions, and at the end of the time the n leading K ions have lost their partners and at the other terminal the n last $O\ H$ ions have also lost their partners. Or we might assume that the K ions remained at their places and only the $O\ H$ ions traveled in a direction opposite to the current; then if no K ions and n $O\ H$ ions cross the imaginary plane, every $O\ H$ ion passes along n K ions and at the end of the time the n leading $O\ H$ ions have lost their partners and at the other terminal the n last K ions have also lost their partners. Or we might assume that both kinds of ions travel in opposite directions, and that, say, y ions K cross the imaginary plane in the direction of the current and $n-y$ ions $O\ H$ cross it in the opposite direction; then, again, at each terminal n ions will loose their partners. We see, therefore, that the fact of n ions becoming free at either end, may be explained in any of these ways, or, in general, by the assumption that y ions K have crossed our ideal plane in one direction and $n-y$ ions $O\ H$ in the opposite direction, where y is a number between zero and n. But it will be seen at once that when we assume different values for y, we obtain different concentrations in each of the two parts in which the electrolyte is divided by our ideal plane; in other words, all other things being equal, the concentration in each of these parts of the electrolyte is a function of y. Hittorf has first worked out this idea, and by measuring the concentration changes at anode and cathode separately, he was enabled to determine the unknown value, called above y. This scheme will become more clear later, when we will apply it to the calculation of the concentration changes in the Edison cell from given values of y.

Hittorf has defined the "transport number of the cation" as the ratio of the number of cations crossing the above ideal plane, to the sum of the cations and anions crossing the same plane in the same time, i. e., the ration of y to n. In the same way he has defined the "transport number of the anion" as the ratio of the number of anions crossing that ideal plane to the sum of the anions and cations crossing the same plane in the same time, i. e., the ratio of $n-y$ to n. These definitions may obviously be given also in the following way: If u and v are the speeds of migration of cation and anion, respectively, the transport number of the cation is $u \div (u+v)$, and the transport number of the anion is $v \div (u+v)$. Any transport number is essentially a positive value between zero and 1.

We will now apply this scheme to the Edison battery. We place our ideal plane parallel to the electrodes through the central part of the cell, so that it represents a cross-section of the liquid between the two plates. The total solution is thus divided into two parts, which may be called briefly the iron part and the nickel part. As there is only very little solution between the plates, by far the greatest part of the solution is in the pores of the iron and nickel plates, and these are also the loci, where the electrolyte is required, because these are the loci of electro-chemical action. Now, suppose the volumes of the iron part and of the nickel part of the solution are equal—which supposition does not restrict in any way the general view of our investigation—and let, in the beginning of the discharge, the concentration of the solution be uniform at all points of the solution. Let there be a chemical molecules $K\ O\ H$ (comprising the K ions and $O\ H$ ions as well as the neutral, non-ionized molecules $K\ O\ H$) and c molecules $H_2\ O$ in the iron part of the solution and the same number of molecules in the nickel part of the solution. And further, let x be the transport number of K, hence $1-x$ the transport number of $O\ H$. We have noticed above that when $2 \times 96{,}540$ ampere-seconds are given out by the battery during discharge, 2 ions K are set free at the nickel plate and 2 ions $O\ H$ at the iron plate. According to Hittorf's views, we must therefore assume that $2x$ ions K have crossed our ideal plane from the iron part to the nickel part of the solution and $2(1-x)$ ions $O\ H$ have crossed the same plane in the opposite direction.

In considering first the iron part of the solution, we see that on account of migration $2x$ ions K have disappeared and $2(1-x)$ ions $O\ H$ have appeared. Further, the chemical change of 1 gram molecule Fe to $Fe\ O$, according to equation (2), has caused the disappearance of 2 ions $O\ H$ and the formation of 1 molecule $H_2\ O$. Hence while we had at the beginning of the discharge a chemical molecules $K\ O\ H$ and c molecules $H_2\ O$, we have now $a-2x$ chemical molecules $K\ O\ H$ and $c+1$ molecules $H_2\ O$; hence during the change of 1 gram molecule Fe to $Fe\ O$, the number of the chemical molecules $K\ O\ H$ decreases by $2x$, and the number of the molecules $H_2\ O$ increases by 1. Both effects act together in diminishing the concentration of the solution at the iron terminal of the cell during discharge.

In the nickel part of the electrolyte $2x$ ions K have appeared and $2(1-x)$ ions $O\ H$ have disappeared on account of migration. Further, on account of the chemical change of 1 molecule $Ni\ O_2$ into $Ni\ O$, according to equation (3), there disappear 2 ions K and 1 molecule $H_2\ O$, while 2 molecules $K\ O\ H$ are formed. Hence while we had at the beginning of the discharge a chemical molecules $K\ O\ H$ and c molecules $H_2\ O$, we have now $a+2x$ chemical molecules $K\ O\ H$ and $c-1$ molecules $H_2\ O$; hence during the change of 1 gram molecule $Ni\ O_2$ into $Ni\ O$, the number of the chemical molecules $K\ O\ H$ increases by $2x$ and the number of the molecules $H_2\ O$ decreases by 1. Both effects act together in increasing the concentration of the solution at the nickel terminal of the cell during discharge.

The results thus obtained for each part of the liquid separately may be summed up in the following statement: When 1 gram molecule O is transferred from the nickel plate to the iron plate during discharge, $2x$ gram molecules $K\ O\ H$ are transferred from the solution at the iron terminal to the solution at the nickel terminal, and 1 gram molecule $H_2\ O$ is transferred from the solution at the nickel terminal to the solution at the iron terminal. The concentration decreases at the iron terminal and increases at the nickel terminal, but the total concentration of the solution is not changed.

It is interesting to compare this result with an analogous calculation, made by Dr. W. Nernst for the lead accumulator (Dr. F. Dolezalek, Die Theorie des Blei Accumulators, Halle, 1901, p. 68), under the assumption that the chemical reactions at both electrodes during discharge are represented by the equations

$$Pb + S\ O_4 = Pb\ S\ O_4$$

and

$$Pb\ O_2 + H_2 + H_2\ S\ O_4 = Pb\ S\ O_4 + 2\ H_2\ O,$$

he finds that when 1 gram molecule Pb and 1 gram molecule $Pb\ O_2$ are changed into lead sulphate, w gram molecules $H_2\ S\ O_4$ disappear at the lead plate, while at the peroxide plate $(2-w)$ gram molecules $H_2\ S\ O_4$ disappear and 2 gram molecules water are formed, where w is the transport number of H in sulphuric acid. According to Hittorf w is $= 0.81$ for an acid concentration of 20 per cent. Hence, at the spongy lead plate 0.81 gram molecules $H_2\ S\ O_4$ disappear, while at the peroxide plate 1.19 gram molecules $H_2\ S\ O_4$ disappear, and 2 gram molecules water are formed, so that the concentration decreases at both terminals. The total concentration of the solution must therefore also decrease.

I will now proceed to complete the calculation of the concentration changes in the Edison storage battery by introducing a numerical value for the transport number. I will give the calculation for both, $K\ O\ H$ and $Na\ O\ H$, as electrolyte. In Ostwald's Lehrbuch der allgemeinen Chemie, v. II., pp. 606 and 608 (1893), a summary of the determinations of the transport numbers x of the cations in these electrolytes at different concentrations is given:

	Liter per gr. mol.	x		
$K\ O\ H$	1.75	0.255	0.285	W
	1.2	0.261	K	
	5.3	0.270	K	
	9.7	0.258	K	
$Na\ O\ H$	0.8	0.161	0.153	W
	0.92	0.173	K	
	3.5	0.200	K	
	9.2	0.157	K	

The transport numbers, marked W, were determined by Wiedemann, those marked K by Kuschel. It seems therefore that the

highest concentrations for which determinations of the transport numbers in these electrolytes have been made, are 1 gram molecule per 1.2 liter for *K O H* and 1 gram molecule per 0.8 liter for *Na O H*, i. e., solutions containing about 5 per cent by weight of the electrolyte. The solution in the Edison battery contains between 10 and 40 per cent by weight of *K O H*, and is therefore considerably stronger. I will assume 0.25 as the transport number of *K* in *K O H* and 0.16 as the transport number of *Na* in *Na O H*, i. e., I assume that the *O H* ions travel with a speed three times that of the *K* ions, and a little more than five times that of the *Na* ions. These values are to be considered, of course, as approximate values only. We obtain then the following results for *K O H* as electrolyte: When 1 gram molecule *O* is transferred from the nickel plate to the iron plate during discharge, 0.5 gram molecules *K O H* are transferred from the solution at the iron terminal to the solution at the nickel terminal, and 1 gram molecule $H_2 O$ is transferred from the solution at the nickel terminal to the solution at the iron terminal. For *Na O H* as electrolyte the result is exactly the same, except that here 0.32 gram molecules *Na O H* are transferred from the solution at the iron terminal to the solution at the nickel terminal. This result corresponds to a discharge of $2 \times 96{,}540$ ampere-seconds. We can, therefore, express this result also in the following form:

When the battery gives out in discharge 1 *ampere-second, the changes in the battery, due to the migration of the ions and to the electro-chemical processes at the electrodes consist in the transfer of*

$$\frac{1}{2 \times 96{,}540} = 0.0000052 \text{ gr. mol. O, or } 0.000083 \text{ gram O}$$

from the nickel plate to the iron plate, the transfer of 0.0000026 *gr. mol.* K O H = 0.000146 *gram* K O H [*or in a* Na O H *solution* 0.0000017 *gr. mol.* Na O H = 0.000068 *gram* Na O H] *from the solution at the iron terminal to the solution at the nickel terminal, and the transfer of* 0.0000052 *gram molecule* $H_2 O$ *or* 0.000094 *gram water from the solution at the nickel terminal to the solution at the iron terminal. This result is entirely independent of the nature of the metals used for the electrodes and ought to be valid for the Edison nickel-iron cell as well as for any other form of this general type of battery.*

It may be well to concisely sum up again the suppositions from which this result has been deduced: They are, first, that the transport of electricity through the solution is accomplished by the ions *K* and *O H* in a *K O H* solution, and by the ions *Na* and *O H* in a *Na O H* solution, the *O H* ions traveling with a speed three times that of the *K* ions and 5 times that of the *Na* ions; and, second, that the chemical reactions at the electrodes are those represented by the equations (2) and (3).

We have so far only considered the changes in the cell directly due to the migration of the ions and to the electro-chemical reactions at the electrodes, and we have found that if our suppositions are correct, during discharge the solution becomes less concentrated at the iron plate and more concentrated at the nickel plate. We must now also take into account the diffusion which sets in as soon as any concentration differences develop. There will also be convection currents. During the whole discharge there will be diffusion and convection, with the result that when the cell has run for some time the concentration changes will be less than found by the calculation given above, because diffusion and convection have then had time to act against the concentration differences. The values, found by the above method of calculation, therefore represent only the upper limit which the concentration changes would reach, if there would be no diffusion and convection. The concentration changes, due to the migration of the ions and to the chemical processes at the electrodes, depend only upon the number of ampere-hours given out by the cell; diffusion which counteracts these concentration changes depends upon the time of the discharge; the quicker a given number of ampere-hours is given out by the cell, the less will be diffusion, and the more nearly will the real concentration changes have the values found by the above calculation, provided that there are no convection currents.

For instance, if one ampere-hour is given out by the cell, the above calculation gives the result for *K O H* as electrolyte that $3600 \times 0.000146 = 0.526$ gram *K O H* are transferred from the solution at the iron plate to the solution at the nickel plate, and 0.338 gram $H_2 O$ from the solution at the nickel plate to the solution at the iron plate. These theoretical values represent the upper limits for the possible concentration changes which will be valid for an instantaneous discharge, say, 3600 amperes in 1 second; with a slower discharge, say, 1 ampere in 1 hour, diffusion and convection have time to destroy the developing concentration differences. The above method of calculation enables one, therefore, to predetermine the amount of electrolyte required for an instantaneous discharge, or, in other words, for high discharge rates. For low discharge rates, however, diffusion and convection may be relied upon to suppress concentration differences, so that only enough electrolyte is required to wet the plates in order to enable the chemical reactions at the plates to take place.

By a calculation, entirely analogous to that of the discharge, we can also investigate the processes during charge. They are exactly the reverse processes. While during discharge the concentration decreases at the iron plate and increases at the nickel plate, we have during charge an increase of the concentration at the iron plate and a decrease at the nickel plate. In both, charge and discharge, the decrease of concentration occurs at the anode. For high rate charges and discharges the anode therefore represents the weak point where there is a possibility of "polarization" setting it. As Mr. C. J. Reed has pointed out in a recent Franklin Institute paper (*Jour. Frank. Inst.*, June, 1901), the "polarization" of an electro-chemical cell may be defined as "electro-chemical fatigue." It is caused by the exhaustion of the reagents at the loci of electro-chemical action and their consequent replacement by other substances which produce a new electro-chemical action. This would occur in the Edison cell at the anode, if during a quick discharge or charge all *K O H* or *Na O H* molecules would be removed from the neighborhood of the anode to the cathode. In practice, it is, therefore, important that diffusion and convection should freely act to bring fresh electrolyte to the anode. For a proper test of the theory, given above, it would, however, be necessary to eliminate diffusion and convection. For this purpose the cathode should be placed horizontally at the bottom of the jar containing the solution, and the anode should be suspended horizontally at the top of the solution. The solution would, according to the theory, concentrate at the cathode which is at the bottom. Convection currents are prevented by placing the plates in parallel and horizontal position at the top and at the bottom. To prevent also diffusion, the cell should be charged or discharged quickly enough. By such an arrangement concentration changes should be obtained which should have approximately the theoretical values.

Let us consider also a case important practically: If at the beginning of a charge the concentration is uniform throughout the cell and we charge it rapidly at a high rate, and after the charge has been completed, we discharge it at once, we should, according to the above theory, have the solution more concentrated at the iron plate and less concentrated at the nickel plate at the beginning of the discharge. During discharge all influences—diffusion, the migration of the ions, and the chemical processes at the electrodes—tend together to decrease the concentration at the iron plate and increase it at the nickel plate. If, however, after the battery has received a full charge, we do not begin at once to discharge it, but leave it at open circuit, diffusion and convection will destroy the concentration differences until the concentration is uniform throughout the liquid, and when we then begin with the discharge, the migration of the ions and the chemical processes at the electrodes tend to decrease the concentration at the iron plate and increase it at the nickel plate, while the diffusion tends to keep the concentration uniform. From the theory one should expect in these two cases of discharge differences in the curves of discharge, especially in the first part and perhaps also in the last part of the curves.

A few words may be added to point out some important differences between the concentration changes in the lead accumulator and our theoretical concentration changes in the Edison battery. In the Edison battery the concentration decreases during discharge at the iron plate and increases at the nickel plate, but the total number of water molecules and *K O H* molecules remains unchanged. In the lead accumulator the concentration decreases during discharge at both plates. In both batteries diffusion and convection will bring fresh electrolyte to the places of lower concentration. In the lead accumulator the electrolyte diffuses from the part between the plates to both sides into the pores of the plates. The concentration in the middle part, therefore, also decreases. In the Edison cell diffusion of the electrolyte takes place from the pores of the nickel plate to the pores of the iron plate. The concentration of the solution, taken as a whole, is not changed, nor can that of the solution between the plates be changed to any considerable degree, so that the above theory of concentration changes in the Edison battery is not in disagreement with the statement of Dr. Kennelly that "the specific gravity of the electrolyte does not appreciably vary during charge and discharge," as

it might be supposed that the measurements of specific gravity have been made in the liquid in the middle part of the cell between the two plates.

From the point of view of our theory there appear to be reasons why the diffusion should act more quickly in the Edison battery than in the lead accumulator. The diffusion is the greater, the greater the differences of concentration and the nearer the places of different concentration. In the lead accumulator the solution in the middle part of the cell, while not altered by the immediate action of the current, diffuses to both sides, as at both sides the concentration has decreased. In the Edison cell there is practically no middle part of the cell, and the places of the concentration differences in the pores of the two plates are very near together, so that diffusion brings the solution from the pores of the nickel plate, where the concentration increases to the pores of the iron plate, where the concentration decreases.

There is another, apparently very important point. We know that the form of the charge and discharge curves of the lead storage battery, and the whole question of the "reversibility" of its action, are intimately connected with the concentration changes in the pores of the two plates (see the book quoted above by Dr. Dolezalek, Chapters VIII. and IX.). The question naturally arises: Are the concentration changes which must occur in the Edison battery according to the theory given in this article of an analogous importance for the working of the Edison cell? But it seems to me premature to attempt an answer to this question as long as experimental data are lacking regarding the influence of the concentration of the solution upon the e. m. f. of the cell and especially upon the e. m. f.'s at both terminals separately.

The Arons Mercury Arc.

BY E. C. ROBERTS.

THE interest excited by the demonstration before the American Institute of Electrical Engineers, at its recent Conversazione, of the mercury lamp of Mr. Peter Cooper Hewitt, has made it seem worth while to call attention to another research carried out along similar lines by L. Arons, in Berlin. In *Wiedemann's Annalen*[1] he published a description of what he called a mercury arc light (das Quicksilber Lichtbogen). He says of it, "While studying gaseous conduction I discovered an extraordinarily good arrangement for maintaining an arc between mercury electrodes for long periods and without any of the usual troubles incident to such cases."

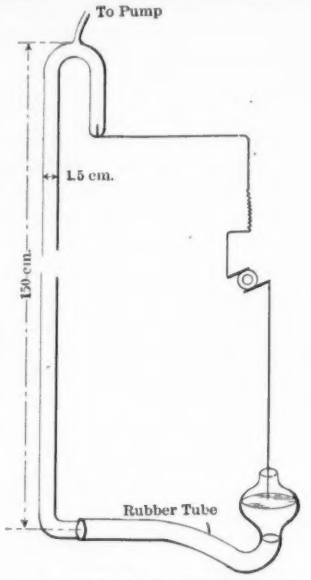


DIAGRAM OF MERCURY ARC APPARATUS.

The apparatus usually took the form shown in the drawing. Here the short leg of an L-shaped tube is sealed off, and provided with an electrode. The other end of the tube is open, and is connected to a mercury reservoir by a rubber tube. The tube is exhausted to a vacuum corresponding to a pressure of 1 or 2 mm. of mercury. When in use the electrodes are connected through a controlling resistance to a source capable of maintaining a difference of potential of about 100 volts. In starting the arc, the mercury is raised in the tube by means of the reservoir till it flows over into the short leg. It is then immediately lowered. As soon as the mercury breaks at the top, a brilliant discharge passes from one electrode to the other. Its color is a greenish white. In two later papers[2] he gives the following results:

1. At currents between 5 and 9 amperes the voltage drop is principally dependent on the length of the tube. Experiment showed that the drop per cm. was approximately .6 volt for a current of 6.5 amperes. The electrode loss is 8 volts at the anode and 6 volts at the cathode.

2. The specific conductivity of the vapor is 6×10^{-10}, which is 8 times as great as that of the best conducting solution of sulphuric acid.

3. The temperature of the discharge was great enough to melt thin platinum wire at the center of the tube. The average temperature was 470 degs. C. above that of the room, while computation based on Warburg's experiments[3] showed that at the center, with a current of 6.5 amperes, the temperature should reach 4600 degs. C.

[1] *Wied. Ann.*, 1892, page 767.
[2] *Wied. Ann.*, 1895, page 625.

Storage Battery Patents.

Among the patents of June 4 are three issued to W. J. Buckley on novel forms of storage batteries. One of these is a high-tension battery—that is, one in which the e. m. f. of each pair of plates is added to that of its neighbor, a number of pairs being contained in a receptacle common to all the elements. The receptacle is divided into compartments by liquid-tight metallic partitions; on one side of a partition and in metallic connection therewith is a positive plate and on the other side a negative plate. These plates do not quite extend to the bottom of the receptacle, so that the electrolyte in a single compartment is in communication with the two partitions of that compartment and the two sides of both plates therein. Another patent describes a battery formed of a number of similar plates, separated by a continuous metal band around the edges of each pair. Any flat plate or grid may be used having a solid metal core or otherwise made liquid tight, should the various elements be included in a serial circuit. When, however, the battery plates are intended to be placed in a cell having an electrolyte common to all the plates, as when in parallel circuit, then the liquid-tight quality of the plates is not essential. In the space formed between plates by the separating metal band is placed powdered or granular carbon, such as wood charcoal. The inventor states he has found that the charcoal used as a separator has the quality of absorbing gases to a high degree. The gas is readily absorbed as fast as evolved, and while the charcoal is to some extent an electrical conductor, and while it is also true that there is a natural electrical potential difference between the carbon and the metallic electrodes, which difference may produce a slight local action in the cell, yet he states that the benefit derived from the use of charcoal over-balances this objection.

A third Buckley patent describes a battery formed of superposed trays separated by an insulating material in the form of a grid. Small notches are cut in the tops of the grid cross bars to give passage to the electrolyte. The grid compartments are filled with coke and oxide of lead. A number of such tray elements are nested to form a cell. The lower tray rests in a wood support the shape of the bottom of the tray, and a similar one, but convex, fits into the upper tray, the two being bolted together. A patent issued on the same date to G. W. Hough, describes a battery consisting of plates of semi-circular form, with pockets formed by cross ribs for the active material, which is filled in flush with the tops of the ribs. The plates are set up in a horizontal position, the negatives forming one half-cylindrical pile, and the positives another similar pile, the whole forming approximately a cylinder, with the two piles electrically separated. Conducting lugs are cast to the edges of each pile.

A patent issued on the same date to C. L. R. E. Menges, The Hague, Holland, describes a storage battery of cellular construction, in each compartment of which are plates of only one polarity. In its simplest form, the receptacle consists of a number of chambers separated by non-conducting permeable partitions. In one chamber there are two positives, one in contact with each partition, and in each of the adjacent chamber two negatives in contact with the respective partitions, and so on. In a practical cell the non-conducting permeable partitions may consist of a supporting piece of insulating material with perforations and channels covered by a porous non-conducting substance, and with active material on both sides. In a patent issued June 11 to V. G. Apple a "two-cell integral unit" battery is described. A lead or alloy case or box is divided in the center by a partition of similar material, thus forming two compartments. The interior surfaces of each compartment is provided with indentations for containing active material, space for the electrolyte being left after the active material is applied. Each of such cells we give four volts. A patent granted June 18 to Wilson H. Abbey and Jacob Altmos describes an element formed of a corru-

[3] *Wied. Ann.*, Vol. 58, page 77, and Vol. 62, page 569.

gated sheet bent to and fro horizontally to form a series of parallel shelves and approximately circular channels between the shelves. The longitudinal corrugations or crimps have spans or lips punched in them at intervals, thus providing openings for the circulation of the electrolyte, and at the same time giving strength to the structure, the span thrust out by the punching bracing the corrugation. The troughs formed by the corrugations are filled with active material, after which the opposite ends of the shelves are dipped into molten lead, thus encasing the element—the lowermost shelf not being perforated.

Convention of the Canadian Electrical Association.

THE eleventh annual convention of the Canadian Electrical Association convened on Wednesday, June 19, at 10 o'clock a. m., at the Russell House, in the city of Ottawa, Ont., and remained in session until Saturday morning, June 22.

The president, Mr. A. A. Dion, of the Ottawa Electric Company, occupied the chair, and the following other officers were in attendance: First vice-president, Mr. E. E. Cary, Montreal; second vice-president, Mr. P. G. Gossler, superintendent Royal Electric Company, Montreal; secretary-treasurer, Mr. C. H. Mortimer, *Electrical News*, Toronto; executive committee, Mr. J. J. Wright, manager Toronto Electric Light Company; Mr. Ormond Higman, chief of Electrical Inspection Department, Ottawa; Mr. A. B. Smith, superintendent G. N. W. Telegraph Company, Toronto; Mr. D. R. Street, secretary-treasurer Ottawa Electric Company, Ottawa; Mr. B. F. Reesor, manager Electric Light & Power Company, Lindsay; Mr. W. H. Browne, manager Royal Electric Company, Montreal; Mr. John Yule, manager Guelph Light, Heat & Power Company, Guelph.

The attendance of members and friends was one of the largest in the history of the association, and the addition of many new members was an indication of the increasing and widening interest in the association.

The complete success of the convention was largely due to the president, Mr. A. A. Dion, general superintendent of the Ottawa Electric Company, and the members of the local reception committee. The electric roads and the doors of many of the clubs were thrown open to the members of the association while in the city.

Mayor Morris, Aldermen Deering and Des Jardines delivered addresses of welcome to the convention. President Dion said it was not his intention to take up the time of the convention with a lengthy address, as the topics usually dealt with, namely, the progress and development of electrical science and industries during the year, had already been fully delineated by the lay and technical press.

He was happy to be able to welcome the members this year to his own city, as he had hoped to do in 1900, but in which he had been disappointed, owing to the disastrous fire which had devastated a large portion of the city of Ottawa during that year.

The report of the secretary-treasurer, Mr. C. H. Mortimer, showed a total membership of 267, composed of 235 active and 32 associate members, being a gain since the last convention of 23.

Mr. J. J. Wright presented the report of the Legislation Committee, showing effective work being done by that committee, but deploring the lack of support received from companies receiving the benefits of the work of the committee, and urging upon the association the need for financial aid, as during the coming year the committee would have plenty of work before them, it being likely two important questions would be taken up by the Government, that of company assessment and the Conmee bill, which provides for the taking over by any municipality of the existing plant supplying light and power, in cases where municipal ownership is desired.

Mr. O. Higman reported for the committee on "Arc Lamp Rating," stating that an amendment to the act had been made at the last session, whereby power was given to fix a standard rating. With this amendment the committee would be in a position to do good work during the coming year.

Mr. F. Nicholls, of the Canadian General Electric Company, voiced the sentiments of many members when he said he had always felt and felt strongly that the executive officers of the association should be chosen solely from members actively engaged in operating companies; and that it was a serious mistake and a menace to the future well-being of the association to have the offices open to those representing manufacturing, supply and other commercial companies, whose interests were to sell supplies to the active members of the association. He thought the fact that there was not a larger number of central station men attending the conventions was due to this cause, and the thought they entertained, whether true or no, that the association was controlled by the selling companies.

Owing to the sickness of Mr. H. L. Doherty, of New York, a paper by him on "Rates for Electric Light," which had been looked forward to with a great deal of interest, had to be foregone.

A paper by Mr. K. B. Thornton on "The Construction and Protection of Aerial Distribution Systems," considered the selection, fitting and location of poles and stringing of lines thereon. This paper will be printed in full in these columns. In another issue will also appear abstracts of papers by Professor R. B. Owens and Mr. J. R. Robertson, the title of the former being "Conversion from Alternating Constant-Potential to Alternating Constant-Current, and of the latter, "The Influence of the Load Factor on the Design and Operation of a Lighting and Power Plant."

DOMINION TESTING LABORATORY.

Mr. O. Higman, of Ottawa, read a paper on the work done under his direction to carry into effect the provisions of Canadian legislation passed in 1894 providing defining electrical units and certain standards.

The resistance standards consist of a Board of Trade and a Reichsanstalt ohm. The laboratory also possesses a resistance box containing 10 1-ohm coils with suitable plugging arrangements for putting the coils in series as a 10-ohm standard, or in multiple as a 1-10-ohm standard; a Kelvin resistance coil of 100,000 ohms with 10 sub-divisions of 10,000 ohms each arranged with plugs for connecting in series or in parallel or any combination of series and parallel, and a Wheatstone Bridge (Anthony pattern) with ratio coils 1, 10, 100, 1000 and 10,000 on each side with bridge coils of tenths, units, tens, hundreds and thousands. These coils are made of manganin specially selected and the box is fitted with an electric thermometer. Measurements of great accuracy can be obtained with this bridge used in conjunction with a sensitive reflecting Darsonval galvanometer. Intercomparisons between the standards are made from time to time, and records kept of their variations.

For the measurement of current a set of Kelvin balances are provided, ranging from 0 to 125 amperes, and for the measurement of power a Kelvin watt balance of 100 amperes and 200 volts. For graduation and standardization a silver voltmeter is used, and a Crompton pentrometer is now being installed. For the measurement of current the "Vienna" method is also employed in connection with a Weston milli-voltmeter.

For measurement of e. m. f. there are two standard Clark cells, three Hibbard cells and a set of six Kelvin special standard multicellular electrostatic voltmeters. Weston voltmeters are used for secondary standards. For photometric measurements a Bunsen photometer and standard sperm candles are used.

A committee was appointed to consider requesting the Dominion Government to establish a bureau for comparing, testing and calibrating instruments under in measuring current and e. m. f. This, it was thought, would be a great advantage, owing to the difficulties at present experienced in having to send these instruments to the manufacturers in the United States for calibration.

BALANCING THREE-WIRE ALTERNATING SECONDARY SYSTEMS.

In a paper with the above title, Mr. L. Denis described the method used by Jacques Cartier Water-Power Company, of Quebec, for keeping its three-wire secondary network in proper balance.

The lighting territory is divided into several districts fed by separate single-phase primary feeders, the power service being supplied for separate circuits. In each district there is a main bank of transformers connected to 108-volt, three-wire secondary mains. The transformers are separated from each other by fused junction boxes in the two outside secondary wires and set midway, electrically, between transformers. The primary feeders are regulated by means of Stillwell regulators from readings taken at different points of each of the banks and carried to the station by pressure wires; the neutral wire is also carried back to the station, so that readings are obtained on each side of the three-wire system.

To apply the method, it is necessary to know (1) the side of the secondary circuit to which the connection is made, (2) what transformer in the bank the connection is made on, (3) what the approximate demand will be.

The method employed to ascertain these three facts is as follows: For each consumer to be connected a form is filled out, giving the

name and address; from the latter the supply transformer is determined, and by referring to the record the best side to connect the consumer is determined. The slip is thus filled out and handed to the service foreman, who returns it to the office as soon as the work is completed. If however, for some reason it is found impossible to follow the slip to the letter, it is handed back showing the actual manner in which the connection was made.

As to the manner in which one side of the secondary is distinguished from the other, the three wires are strung on a four-pin cross-arm, using three consecutive pins, and the same relative position is maintained all along the line. This gives at each pole the same two wires (one outside and the neutral) separated by the pole; and the other two (the other outside and the neutral) with nothing between.

As to the second point, maps of the different districts of the city are kept up-to-date, and show the secondary line and taps, and the exact position of transformers and junction boxes. Knowing a consumer's address, his exact location is ascertained and the transformer feeding the nearest mains determined. The transformers are distinguished from each other by numbers painted thereon.

When it found from the records that a transformer in a bank is being overloaded, it becomes necessary to have the transformers at that point nearer one another, which means that another transformer has to be inserted, and possibly the existing ones moved. To get at the best position for this new transformer, what may be termed "trial records" are made out from the original connection slips belonging to the transformer or transformers to be relieved, by placing the new transformer and its junction boxes in different imaginary positions on the map, and choosing the position which gives the best results on these "trial records." These "trial records," although very nearly correct, cannot be relied upon as absolutely accurate, and an inspection of the line has to be made after all changes are completed to determine exactly what customers have been changed from one transformer to the other, and the records are changed accordingly.

As to determining the demand of consumers, this is governed mainly by the rate under which a consumer contracts, but in some cases also by the class of consumer to be served. For ordinary meter consumers (residences and stores of moderate size), 40 per cent of the total installation is taken as a maximum demand; for the larger stores and manufacturers individual factors are assigned, which generally vary from 75 per cent to 90 per cent of total installation. For consumers on the flat rate, 90 per cent of total capacity contracted for is taken. Consumers on limited capacity system are the most easily dealt with, as naturally the maximum demand contracted for must be taken as their maximum demand without introducing any factor whatsoever.

As indicating the success of the system described, it is pointed out that in spite of the very rapid growth of the plant (over 30,000 lamps of 16 candle-power having been connected in about one year) not one case of burnt-out transformer from overload has occurred, and only three cases of blown fuses.

In answer to an inquiry, Mr. Denis said that the "fused junction box" referred to in his paper was an ordinary street car motor fuse box. The fuse to be used should not be above a third of the capacity of the transformers that are banked. Sometimes this had to be exceeded in cases where proper line arrangements could not be obtained. These junction boxes were inspected every weak and any fuse which was blown replaced, the ordinary common fuse being used.

Topical discussions were had on "The Best Practice in Cleaning, Trimming and Inspection of Enclosed Arc Lamps," and "The Different Systems of Charging for and Measuring Power Consumed by Induction Motors with Varying Power Factors."

Mr. F. H. Leonard, Jr., said there was a variety of methods in vogue, one being that of charging a fixed rate per horse-power which was in a measure modified by the amount of power used on the average. There was one suggestion in connection with this which was that the time for using the power should be limited to certain hours to prevent overlapping the lighting load.

Some of the members thought if the consumers of power were approached properly there would not be much difficulty in obtaining contracts on this basis, unless in exceptional cases. The method of charging on a meter basis for the motor load was necessarily a heavy tax on the consumer of power, as it meant the carrying of reserve apparatus by the power companies, and they must have a price which would compensate them for the carrying of such reserve apparatus.

Mr. J. J. Wright presented the report of the Nomination Committee to strike the standing committees, which, on motion was adopted and is as follows:

Committee on Statistics.—Messrs. A. A. Wright, K. B. Thornton and J. F. H. Wyse.

To Confer with Underwriters.—Messrs. P. G. Gossler, Edward Slade, A. A. Dion, Alderman Sadler, A. Sangster and J. J. Wright.

On Arc Light Rating.—Messrs. O. Higman, P. G. Gossler, Fred Thomson, John Yule, Professor Owens, J. M. Robertson and Mr. Lambe.

On Legislation.—Messrs. John Yule, B. F. Reesor, A. A. Wright, C. B. Hunt, W. H. Browne, A. A. Dion, W. H. Briethaupt, R. O. McCullough and J. J. Wright, with power to add to their numbers.

On Standardization of Accounts.—Messrs. D. R. Street, A. A. Wright and Mr. Henshaw. (Same committee continued.)

The social programme for the convention was excellently prepared and timed. It consisted in the annual banquet, at which about 150 members and invited guests sat down. A band concert at Brittania-on-the-Bay was given through the courtesy of the Ottawa Electric Railway Company; an exhibition by the Ottawa Fire Department was given at Hotel Cecil, followed by a trip to Rockliffe Park and Rife Ranges; a visit to power houses and other points of interest at the Chaudiere. Trip to Queen's Park, Aylmer, through the courtesy of the Hull Electric Company, stopping at Deschenes Rapids to visit the power houses of the Hull Electric Company and the Capital Power Company. There was also tendered by the citizens of Ottawa a carriage drive around the city. The association was photographed on the main steps of the Parliament Buildings. The election of officers, which took place on Friday morning, resulted as follows:

President, P. G. Gossler, Montreal, Quebec; first vice-president, B. F. Reesor, Lindsay, Ont.; second vice-president, Edward Slade, Quebec City; secretary-treasurer, C. H. Mortimer, *Electrical News*, re-elected.

Executive Committee (five members re-elected).—Messrs. J. J. Wright, Toronto; John Yule, Guelph; A. B. Smith, Toronto; W. H. Browne, Montreal, and O. Higman, Ottawa. (Five new members elected)—Messrs. A. A. Dion, Ottawa; J. Murphy, Ottawa; A. Sangster, Sherbrooke, Quebec; W. G. Holman, Quebec City, and K. B. Thornton, Montreal, Quebec.

The committee on drafting amendments to the constitution re-membership brought in a report, but owing to a provision of the constitution that this report could not be adopted until the following day after its presentment, and in order that it might not lie over for another year, a special meeting was called for Saturday morning, after which the convention adjourned to meet in Quebec City in 1902.

St. Lawrence Power Company.

The new electric development works of the St. Lawrence Power Company, at Sheik's Island, Ont., were primarily intended for the sole purpose of lighting the Cornwall canal, but the company will probably transmit power also to Montreal. The power for the working of the plant will be supplied by water from the Cornwall canal, through a very short head race, and will discharge directly into an old channel of the river St. Lawrence. The first development will provide for 4000 horse-power, under a head varying from 20 to 30 feet. There will be installed at once 1000 horse-power. It is expected that 15,000 horse-power will be developed when the demand warrants the production of this amount. The generators to be installed are of the rotating field type, of 750-kw capacity, designed to deliver three-phase currents at 2200 volts. There will be two exciters, each of 50-kw capacity, and either one is sufficient to excite the four generators which will make up the capacity of the station. The step-up transformers, of the air-blast type, are to be installed on the first floor of the wire tower, where the potential will be raised from 2200 volts to 11,000 volts. The circuits will fan out in both directions from the tower, to heavy station poles. Cedar poles, trimmed and painted, will take the lines mostly along the south bank of the canal. The lighting and power lines are supported by the same poles, which are spaced about 100 feet apart, every fourth pole supporting a series alternating enclosed arc lamp. The locks are provided with from six to thirteen lights, and motors are provided for handling the sluice gate and for opening and closing the lock gates. The generators, exciters and other station equipment will be installed by the Bullock Manufacturing Company, of Cincinnati, Ohio. Messrs. T. Pringle & Son, of Montreal, are engineers for the entire installation.

Twentieth Annual Convention of Railway Telegraph Superintendents.

THE twentieth annual meeting of the Association of Railway Telegraph Superintendents was held at Statler's Hotel, Buffalo, N. Y., on June 19, 20 and 21. The first session was called to order at 10.15 a. m. Wednesday by President W. F. Williams. He called on Mr. Henry W. Pope, a resident member of the association, who made a few remarks of welcome. After referring to Buffalo and its many attractions, he extended to the ladies of the party an invitation to visit the Bell Telephone Company's exchange in the afternoon, where a luncheon would be served. He also extended, on behalf of the general manager of the Long-Distance Telephone Company, and of his own company, the Buffalo Company, the courtesy of free telephone service during the convention. Another courtesy extended by Mr. Pope on behalf of his company was a trip to Niagara Falls by special trolley car, which was set for Thursday afternoon. After doing the honors, Mr. Pope referred to the new work of his company. The service, he said, had been entirely renovated, and when the improvements were completed the Buffalo Company would have a plant modern throughout, which would equal any in the world.

Mr. Charles Selden, on behalf of the association, replied in a fitting manner to Mr. Pope's welcome, after which the business of the meeting was taken up. After the election of new members, Secretary-Treasurer Drew read his report for the past year. The report showed the association to have a balance on the right side of the account, the association being free from debt.

The next order of business was the election of officers and the selection of the place for the next meeting. It was decided to go to Boston. The following-named gentlemen were elected for the ensuing year: President, C. F. Annett, of Chicago; vice-president, F. B. Valentine, of Boston; secretary-treasurer, P. W. Drew, of Milwaukee. Mr. Annett was at once conducted to the chair. He thanked the association for the honor conferred upon him. Mr. Valentine, the new vice-president, also made a few remarks of like nature.

The secretary read a letter from Mr. T. A. Edison in reply to an invitation from President Williams to attend the meeting. Mr. Edison expressed his regrets at not being able to be present. He stated that his absence in the South and the consequent accumulation of laboratory work, together with the great demands upon his time in connection with the bringing out of his new storage battery, kept him so closely applied that he could not spare the time to attend.

Secretary Drew also read a letter from the Interstate Commerce Commission asking for a sketch of the association and its work, for the purpose of incorporating the same in the Commission's report. Mr. Drew stated that he had supplied the desired information. Several letters were read from electrical exhibitors at the Pan-American Exposition inviting the members to visit their exhibits.

The next order of business was of a rather unique character. A Phillips-Morse transmitting instrument had been connected up in the meeting room, and it automatically transmitted a story entitled "Troubles on No. 4 East." "No. 4 East" was a celebrated press report wire several years ago between Boston and New York. The operators constituted a rather exclusive set, and when a strange operator chanced to be assigned to that wire at any one of the many offices on the circuit he always received a warm reception. The story ticked off on the instrument was a reproduction of the work on "No. 4 East" on an occasion of this sort, and created much merriment among the members, especially those who had been personally familiar with the peculiar ways of the "No. 4 East" clique. After the instrument had told its story, Mr. J. J. Ghegan read a paper prepared by Mr. Walter P. Phillips, entitled "Rapid Telegraphy," an abstract of which will be given in a subsequent issue.

This paper was followed by one read by Mr. Selden, in which was described an instrument called the "Voltaplex," devised by Mr. H. D. Bartholomew, of the Baltimore & Ohio Railroad at Newark, Ohio. The principle of the Voltaplex is analogous to that of simultaneous telegraphy and telephony and the phonoplex system of telegraphy, in that graduating apparatus is employed to avoid interference between the two sides of the usual artificial line of the duplex system. The Voltaplex instruments are connected in the line as an auxiliary to the Morse system, and are operated entirely independent of the latter, neither system interfering with the other in any particular. The effect of the graduating device of the voltaplex upon the lien is to slightly prolong the Morse signals and to absorb the extra current at the moment of make and break of the Morse circuit. A condenser affords a path to ground for the voltaplex currents. The transmitting coil is of special construction. There is no transmitter in the arrangement; the key, relay and sounder comprising the only instruments with which the operator has to do. The construction and operation of the special apparatus in its relation to regular circuits were illustrated by means of diagrams. The voltaplex, as an open circuit system for equipping lines independent of the Morse, it is thought, should find a large field. Very satisfactory results have been obtained in various tests made over wires of different lengths and capacities, a recent test between Newark, Ohio, and Pittsburg, Pa., a distance of 180 miles, over a No. 10 copper wire, gave exceptionally good results.

Mr. W. E. Athearn then read a paper giving an account of his experience with storage batteries in telegraphic work, with some information as to the care of cells. At the Jersey City terminus of the Central Railroad of New Jersey 500 local gravity cells were displaced in 1894 by storage batteries. The first cost of the storage plant was a little over $200. No expense was entailed for the first two years, but a new set of positive plates was put in at a cost of less than $100. At the end of six years a complete new battery was furnished, but many of those cells are still in use where the demands of capacity are lighter.

A simple rule given as to the capacity of batteries is to allow one ampere-hour for each single telegraph wire that is to be supplied. This is based on a 24-hour service, ample allowance being made for the gradual wearing out of the cells. An experience of over five years with nearly 20,000 storage batteries has demonstrated the correctness of this rule.

At Jersey City there are two distinct sets of batteries for the main lines. One set furnishes current to the telegraph wires for 24 hours and is then put on charge over night, while its companion bank of cells takes care of the telegraph service during the succeeding 24 hours. This makes the work easy for both banks, and would permit the maintenance of the service for four days, even if the electric light plant should fail, and no fresh charge could be put into the cells for that length of time. The locals are also taken care of by the use of four cells of 125 amepere-hour capacity. Two cells charge in series and discharge in multiple. One leg of the electric light branch that furnishes light to the operating room, is looped down, so that all the current passing to these lamps also passes through the two storage cells in series. This causes a drop in voltage of that particular room from 110 to between 105 and 106 volts. Lamps of the latter voltage are used, when full candle-power is expected from them. The reason for using four cells, instead of two, is that the current in that particular branch of the light service would not put sufficient charge into one storage cell to enable it to supply the 20 or 30 4-ohm sounders they require in their service.

In the discussion of Mr. Athearn's paper, Mr. Jacoby, of the Lehigh Valley Railroad, gave the experiences on his lines with storage batteries. Prior to the adoption of such batteries for furnishing current for the operation of the telegraph circuits, current was supplied by a dynamo driven by a water motor. This motor, however, was expensive to operate, the cost for water alone being $20 per month. By the substitution of storage batteries the cost of maintenance had been reduced three-quarters, and the company saved $3,000 to $4,000 a year.

A paper entitled "Cipher Code for General Railroad Telegraphing" was read by Mr. C. S. Rhoads. A reference to this paper will be found on another page of this issue. The reading of the paper was followed by a discussion, after which a committee was appointed to take up the subject with a view to devising a code that could be applied to all railroad telegraph service, and report its findings at the next annual meeting.

After the reading of a paper by Mr. A. R. Swift, of the Rock Island road, on "The Inefficiency of the Ordinary Operator," the meeting, at 12.45 p. m., adjourned until 9.30 a. m. Wednesday.

The afternoon and evening were spent by the members at the Pan-American Exposition.

Thursday's meeting was called to order at 10 a. m. Mr. T. D. Lockwood read a paper entitled "The Importance in Telegraphy of Apparently Little Things."

In a paper entitled "The Importance in Telegraphy of Apparently Little Things," Mr. Thomas D. Lockwood discussed many details

relating to telegraph lines, batteries and operating instruments. He considers that the regular twist joint used in this country is superior to the Britannia joint. Iron line joints ought to always be soldered, and Mr. Lockwood believes in a general soldering campaign at intervals of, say, three years. As to copper wire, the twist joint should not be employed, and such joints should not be soldered, owing to the risk of burning the wire. Either the two-sleeve McIntyre or the three-wire joint should be employed. As to glass and procelain insulators, it is a question whether carefully tested porcelain insulators would not along the coast and for some 50 miles inland be a material improvement over glass insulators. In making ground connections a water pipe should be chosen in preference to a gas pipe; but if the latter only is available, the connection should be made, if possible, on the street side of the meter. A comparatively small pipe should be chosen in preference to a very large one, and the surface filled or scraped clean, and a copper wire of many turns soldered about the same.

Mr. Lockwood recommends the instruction of young operators, not only in sending and receiving Morse, but also in everything that can be taught about the line, instruments and batteries with which he is to be associated, and there might properly be a regular inspection system for lines, batteries and instruments, but especially the two latter—this being so carried out that each office should be thoroughly inspected at least twice a year.

The two ideas might be combined in the person of a suitably qualified, and well experienced operator, who visiting offices periodically could not only perform such personal inspection, but could likewise devote a portion of his time to the questioning and instruction of the younger operators; and in some cases also of such of the older ones as do not already know it all or are not too old and case-hardened to learn.

In the discussion of this paper Mr. A. B. Taylor spoke of the importance of properly insulating wires leading into buildings from outside lines. He called attention to common errors of construction men in doing such work, and pointed out the proper means to be observed to secure the desired results. Mr. Drew stated that the use of staples on inside wiring was not allowed by his company under any circumstances, as they were a source of much trouble. Messrs. Athearn, Maver, Lockwood, Taylor and Ryder made brief remarks on the relative advantages of oils, tallow, etc., for use in gravity cells to prevent evaporation of the liquid. Mr. Lockwood favored tallow because it caked and could be readily removed when necessary. Mr. Taylor referred to the destruction of the rubber insulation on the wire leading to the copper of gravity cells, at the point where the wire entered the liquid. Mr. Maver explained that this effect was due to the corrosive action of oil on rubber. A wire insulation was made, however, and is used by the Western Union Company, which avoids this difficulty entirely.

Mr. F. P. Vallentine, of the New York, New Haven & Hartford Railroad, Boston, then read an instructive and interesting paper on the use of the telephone in railroad work, after which the meeting adjourned in order to make the trip to Niagara Falls. An abstract of this paper will appear in a following issue.

Immediately after the opening of the meeting on Friday Mr. E. A. Chenery read a letter from Mr. G. A. Clark, superintendent of the Omaha Bridge & Terminal Company, in which he (Mr. Clark) gave an account of the use of the telephone in the dispatching of trains on his company's system. Mr. Clark stated that the telephone system had been in operation over a year, during which time there never had been an accident, an error or any misunderstanding. In several respects, Mr. Clark considered the service far more efficient than that of the telegraph.

After a discussion on Mr. Vallentine's paper read on Thursday the subject of handling trains by telephone was next considered in all its bearings, and the questions asked by members indicated that many were deeply interested in this matter.

Mr. William Maver, Jr., was next called upon for some remarks on the Strowger automatic telephone. He stated his inability to make the demonstration of the operation of the system, as he had intended, for the reason that the apparatus which he had expected for the purpose had gone astray. In this connection, he referred to the unique means that had been planned to provide the necessary direct e. m. f. to operate the apparatus. The lighting current in the hotel was alternating, and that could not be used without a rotary transformer; and primary batteries could not be considered on account of the large amount of room necessary for them, not to speak of other objections. It had been decided, therefore, to hire three automobiles and get the necessary voltage from their batteries.

In lieu of the talk on the Strowger apparatus he gave some practical information on the subject of underground cables for railroad telegraph work. He compared the advantages of paper and rubber-insulated cables, both classes of which, however, should always be had covered for protection. He advised the use of ducts in places where there was danger of mechanical injury, or where electrolytic or chemical action was likely to occur. In such circumstances rubber insulation should be used in preference to paper, for the reason that should the lead sheathing be punctured or corroded the rubber insulation might still be depended upon, whereas in the case of a paper covered conductor the entrance of moisture would soon destroy the insulating properties of the paper. In answer to a question, Mr. Maver stated that the use of jute covered cables in underground work had been abandoned—lead covered cables being now used altogether. Under favorable conditions lead-covered cables could be laid directly in the earth.

Dr. Cardwell being called upon made a few brief remarks about his typewriting telegraph system, which is now being experimentally operated on the Lond Island Railroad. Mr. L. S. Wells, superintendent of telegraph of the Long Island Railroad, stated that it was giving very satisfactory results, and had been working for a long time without any attention whatever.

A resolution of thanks was then passed for the many courtesies extended to the association by the telegraph companies, the telephone companies and others, and especially to Mr. Henry W. Pope, of the Buffalo Bell Telephone Company, who had taken such pains to provide for the entertainment and comfort of the party.

The convention then adjourned.

Storage Battery Auxiliaries—IV.

BY LAMAR LYNDON.

THE DIFFERENTIAL BOOSTER (*Concluded*).

IN the preceding article the differential booster was discussed, being considered with the connections, as shown in Fig. 9, which is here reproduced. The generator current is, in this case, all passed through the coil S_1, which, therefore, produces a m. m. f. proportional to the generator load, which combined with the other m. m. f.'s from coils S_2 and f produces the resultant booster e. m. f.

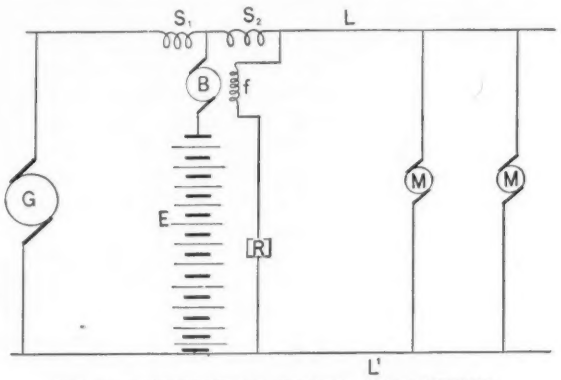


FIG. 9.—DIFFERENTIAL BOOSTER CONNECTIONS.

It is, therefore, evident that if the coil S_2 can be made to give a m. m. f. proportional to the generator current, the booster will work under the same operative conditions as if it were connected, as in Fig. 9. The series coil S_2 is sometimes connected between the equalizer and positive bus-bars when operated with compound generators, as shown in Fig. 10. In this case the current in the coil, while not in series with the generator current, gives an e. m. f. proportional thereto. To calculate the turns on S_1 it is necessary to know the drop through the series coil of the generators, or what amounts to the same thing, the difference of potential between the positive and equalizer bus-bar at normal load. The turns on S_1 are then calculated as shunt coils producing a given armature e. m. f. with a definite voltage at its terminals.

This form of connection is most desirable where the generator current is large as compared with the maximum battery current and

reduces the size of wire required to be wound on the field, though it does not reduce its volume nor the weight of copper, as compared with the regular series connection.

The sudden current rush from generator on increase of load is very much less in the differential than in the compound booster system, because of the self-induction of S_1 and S_2, through which all current passes to reach the outside load where the connections are, as shown in Fig. 9. If the booster be connected, as shown in Fig. 10, the reactance of S_2 only, can assist in choking back the current rush S_2, however, usually has a much smaller inductance than S_1,

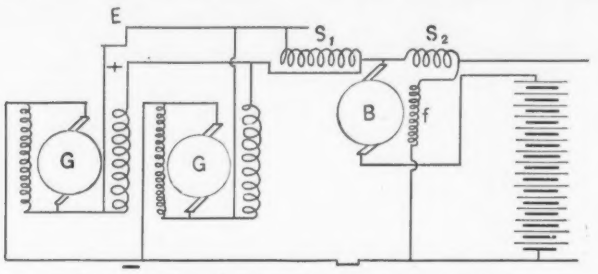


FIG. 10.—DIFFERENTIAL BOOSTER CONNECTIONS.

and the booster therefore will operate more satisfactorily on rapidly fluctuating loads when S_1 is connected in series with the generator current.

Double commutators may be necessary on differential boosters under conditions of small V and I_0 very great—generally on low potential systems.

Fig. 11 shows the switchboard in complete detail of a differential booster system. The combinations possible are:

(*a*) Generator feeding directly to bus-bars, battery and booster out of service.

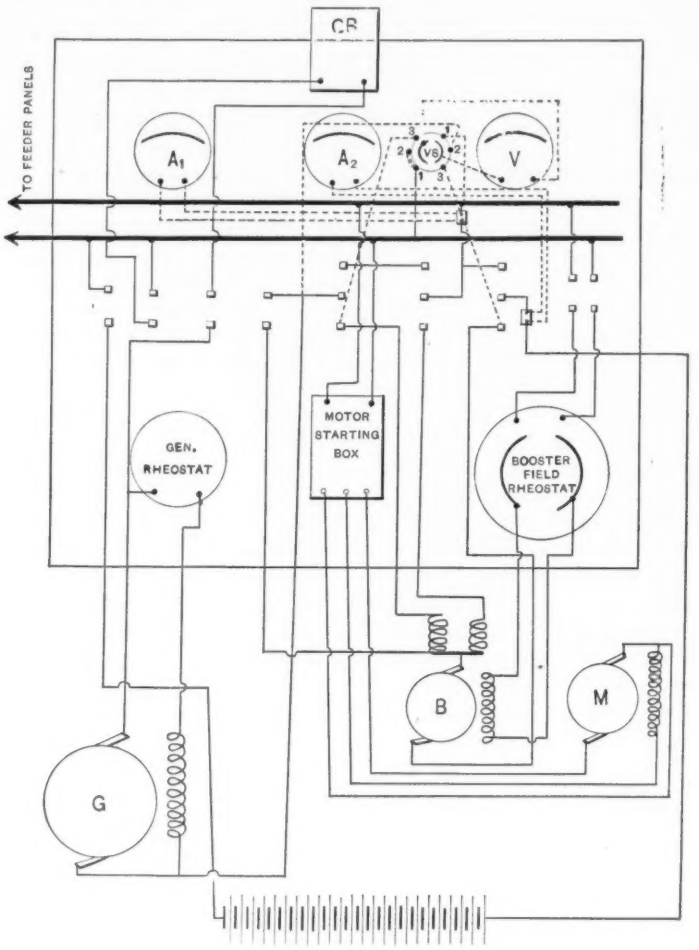


FIG. 11.—DIFFERENTIAL BOOSTER SWITCHBOARD CONNECTIONS.

(*b*) Generator feeding to bus-bars, battery in parallel with bus-bars.

(*c*) Booster in series with battery, series coils operating, booster and battery connected across the line.

(*d*. Booster in series with battery, series coils short-circuited, battery charging only.

If the negative bus-bar be connected to the ground and the positive carried on to feeder panels, the diagram shows the complete arrangement as applied to railway systems.

The Los Angeles 33,000-Volt Transmission Plant and Electric Railway.

The Edison Electric Company, of Los Angeles, Calif., is of special interest as owning and operating a 33,000-volt transmission line, 83 miles long, from a power plant in the cañon of the Santa Ana River northeast of San Bernardino to Los Angeles.

This line and power house were originally built by the Southern California Power Company, and the transmission is popularly still known by that name. O. H. Ensign, chief engineer of the company, is able to give many interesting and valuable points regarding the operation of this line. Both Mr. Ensign and the others connected with the company agree that there is no more practical difficulty in operating the 33,000-volt transmission line than in operating the 110-volt circuits around town, and they laugh at any one who considers operation at that voltage anything but a simple and practical matter. Their experience with it has evidently been sufficient so that it is no longer a matter of any more than ordinary consideration.

The transmission line for the most of the way follows the Southern Pacific Railroad. There are two three-phase circuits on the same poles; both of No. 1 B. & S. medium hard-drawn copper wire on Imperial porcelain triple petticoat insulators, mounted with the petticoat 4 inches above the cross-arm. Only one of the two circuits has been used at a time so far, as there has been no necessity for doing it to keep down the loss in line and the effect of putting the two long lines in parallel is somewhat feared. When the necessity arises, Mr. Ensign thinks it will be time to try it. As at present operated one line is ordinarily used, and the other kept idle in reserve. When such a heavy short occurs on the line that is in use that it is necessary to stop using that line the sub-stations have to be shut down for a short enough time so that the switches can be thrown onto the other line. In making such changes current is cut off from the high-tension transformers at the power house before changing the high-tension switches.

In spite of the fact that the line wires are only from 18 to 24 inches apart in some places arcs do not hold long between wires when once started. However, if the line were to be built over again the wires would be given greater separation, because arcs are more likly to be started by birds and sticks thrown across than if the wires were farther apart. The porcelain insulators on this line were all tested with a 10-kw transformer to 70,000 volts before being put up. It was in the erection of this line that the fact was first forcibly demonstrated that insulation breakdown tests of insulators must have plenty of transformer capacity behind them, otherwise the leakage over the insulator may be heavy enough to seriously pull down the voltage of the testing transformer. Only one insulator has proved defective on the entire 83 miles in two years of operation. Of course, some have been broken by being shot at. The high-tension sides of the transformers are connected Y-fashion, and the neutral grounded. This, of course, throws a greater strain than would otherwise be on the insualtors, especially when the poles and cross-arms are wet, as there is 1900 volts between wires and ground. Strange as it may seem, there is one case on record where a line wire lay directly on the cross-arm without setting the arm on fire.

Another peculiar thing noticed on this line is that when a broken insulator permits leakage onto the pin and cross-arm and thence down the pole to ground the cross-arm is burned only where it touches the pole. The electrical contact between the cross-arm and pole is evidently not very good. The 83 miles of line is looked after by two patrolmen, and both of these have other duties—one at the power house and the other at a sub-station. An average of about 90 owls and other birds fly into the line in a year. This starts an arc which in most cases lengthens itself out in the air until it breaks. When a short of this kind occurs the attendants at the sub-station usually succeed in pulling through without shutting down the synchronous motor generators, of which there are a number on the line. This is done by instantly tripping the circuit breakers on the direct-current ends of the motor generators, and then opening the field switches of the synchronous motors just far enough, so that the field circuits are closed through a resistance by means of a small auxiliary contact on the switch. The synchronous motors are

thus run as induction motors without load for a few seconds until the short is off the line. The fields are then thrown in again, the motors jump into step, and the circuit breakers are closed on the direct-current side to resume regular operation. No fuses are put in the high-tension line or at the power house, except that the generators are fused to 4 or 5 times their capacity. Occasionally one of these fuses blows, but is replaced before the service is interrupted.

The power house is now delivering about 3000 horse-power. It contains four 750-hp G. E. revolving field, 50-cycle, 750-volt, three-phase generators direct connected to Pelton wheels, operating under a 728-ft. head. Generators of this type connected to waterwheels do not give sufficient current on short circuit to endanger their windings, hence the practicability of running without fuses. Indeed fuses would be very much of a nuisance on these lines.

It has been claimed that climate conditions are favorable in Southern California for such transmissions. They are as regards freedom from lightning, although there is some of this, and there is plenty of rain. The most trying thing, however, is the ocean fog which sometimes drifts up the valley and covers everything with moisture. In such cases the pole tops at high points on the line are luminous at night, but the leakage on the 83 miles of line is less than 500 watts at such times. The lightning arresters used on this line are G. E. Wirt with 1-16-inch gaps between cylinders, and one gap to every 400 volts potential across their terminals, making 48 gaps in all. There is a static discharge continuously between the gaps for about half the distance to ground. The balance of the gaps are silent. General Electric air blast transformers are employed on all the 33,000-volt work and none has ever been burned out.

The management of this company is a firm believer in the superiority of motor generators over rotary converters for use with a frequency as high as 50 cycles. Mr. Ensign claims as high all day efficiency for them as for rotary converters where the sub-station is supplying both alternating and direct current as is the case in most transmission plants. If rotary converters are used two sets of static transformers must be put in, one set for supplying the rotaries and the other for supplying alternating current for distribution. With motor generators one set of static transformers only is needed and they can be worked at higher efficiency than two sets. With synchronous motor generators there is no trouble with pumping or

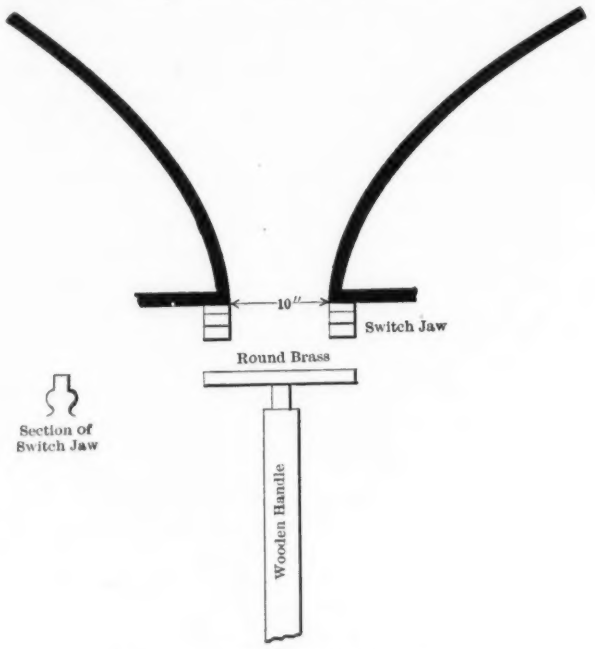


FIG. 1.—HIGH-TENSION SWITCH.

surging as there is likely to be with high frequency rotaries and the high commutator speed of the rotary is done away with. The synchronous motors are always started as induction motors with unexcited fields.

The high-tension switch used on the 33,000-volt lines is very simple, and is not as formidable looking as the long break switches in use on most lines of this kind. It is constructed on the principle shown in Fig. 1. The distance between the switch jaws is but 10 inches. Extending upwardly from the jaws is a pair of horns made of line wire. Connection between the switch jaws is made with a piece of round brass rod attached to a long, dry wooden handle. This brass rod and handle is kept from falling out of the switch jaws when the switch is closed by the spring catch shape of the jaws as shown in the section in Fig. 1. When it is pulled down out of the switch jaws the arc is carried up between the horns by the heated air and is broken. This switch has never failed to break the circuit when opened under any conditions which have so far existed. Of course it is seldom used as most of the circuit opening is done is done first on the low-tension side of the transformers at both power house and sub-stations. The main use of these switches when opening live loaded circuits would be in case a transformer should begin to burn out. Although not at present so arranged the sub-station will have these switches put in each transformer circuit as well as in the high-tension lines as they enter the sub-station.

The insulators on the line are put on wrought iron pins with a wooden sleeve 4 inches high, covering the pin between the insulator and the cross-arm. In constructing another line, in view of his past experience in testing insulators at high voltage, Mr. Ensign would use a porcelain insulator with a single petticoat mounted on a pin with a cast-iron shoulder, with a sulphur joint between the pin and insulator. He would make the bolt hole in the cross-arm for the pin large enough to be a loose fit so that a lineman could quickly take out one insulator and pin and put in another. The bolt could be screwed tight enough to hold the pin firmly.

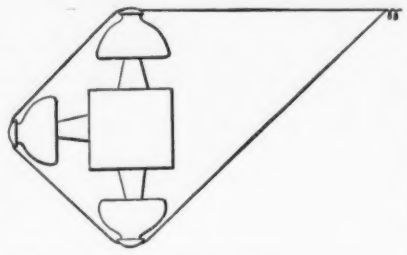


FIG. 2.—STRAIN INSULATORS.

The 83-mile transmission line is now being sectioned, with outdoor switches at the end of each section for transferring from one line to another to make repairs without shutting down the sub-stations. At spans across streams insulators are arranged to take the strain according to Fig. 2.

This company is decidedly in favor of porcelain as against glass for high tension lines because of its mechanical strength.

It is of value to note with what entire success the telephone line is operated on the transmission line poles, even though the transmission line is run with a grounded neutral. It shows that there is very little leakage on the transmission line. The telephone wires are run 6 ft. below the transmission line on pony glass insulators.

Some odd stories are told regarding the behavior of the 33,000-volt current. A lineman climbing up over a transformer case got his head so near one of the high-tension wires that an arc jumped across the air space to his head. The voltage between the transformer case and ground was about 19,000 volts. The man was picked up for dead, but was resuscitated. A hole was burned in his skull and the skin burned off the soles of his feet. Skin was grafted on to replace his loss and the man recovered, at last accounts being in the employ of the General Electric Company at Tacoma.

The most peculiar freak of the 33,000-volt current, however, happened in the Santa Ana Cañon. One of the transmission line poles was guyed to a large boulder by means of an eye bolt in the boulder. One night an arc got started from one of the lines to the guy wire. An employe of the company passing along saw the flame and rushing to the nearest telephone told the power house that a pole was on fire, to get ready to shift over to the other line. The employees at the power house spent a few anxious moments watching the instruments and preparing to switch over on a moment's notice. Minute after minute went by, but no sign of any line disturbance showed on ammeter or wattmeter, nor had there been any noted previously. A party was sent out on the line, but could not find the burning pole. All was dark. The next morning the pole was found. The arc had broken itself, but not before the boulder, through which the current was seeking ground with 19,000 volts behind it, had sweat great drops of slag and burst. The company has evidently discovered a new way to break up rock. The volume of current required must have been very small. as it was not detected by the station instruments.

SIX STATIONS IN PARALLEL.

The Los Angeles Railway serves as a kind of dumping ground for the surplus power generated by both transmission companies. In the winter when water is high in the cañons the water power plants are able to carry a considerable railway load. In the summer if necessary the railway feeds power into the transmission com-

panies' sub-stations. The arrangement is advantageous all around. The railway gets cheap water power when available, and the transmission companies are able to carry a larger light and motor load than would otherwise be possible.

There are now six power houses and sub-stations in and near Los Angeles connected in parallel, viz., the Los Angeles Railway power house, the Edison Electric Company sub-station, the San Gabriel Electric Company sub-station, the Los Angeles-Pacific Railroad power house, the Los Angeles & Pasadena Electric Railway power house at Pasadena, and the San Gabriel Electric Company sub-station at Pasadena.

Steam Engine Specifications.

The Engine Builders' Association of the United States has submitted for the consideration of architects and engineers the following suggestions in connection with specifications for the installation of steam engines:

First.—That contracts which provide a penalty for failure to deliver in time or for failure to meet guarantee ought also to provide equal premiums for earlier or better results than specified.

Second.—That bonds should not be required on installation contracts unless corresponding bonds for similar amounts are given to secure payment. An exception always being made in the case of Government, State or municipal contracts.

Third.—That settlements or any part of them ought not to extend beyond three months from completion of contract, and that delay on the part of the owner ought not to delay payment beyond a reasonable time.

Fourth.—That a guarantee against defective material or workmanship should not be made to cover a period of more than one year from date of shipment.

Fifth.—That purchasers of engines ought not to be furnished with complete working drawings, but simply with general drawings showing the assembled engine in outline, with such principal dimensions as will answer for building foundations, the erection of engines or their care.

Connectors for Electric Furnace Electrodes.

The electrode holder for the arc light carbon was a highly developed structure before the electric furnace, in the modern sense of the term, came into existence. But when the problem arose of transmitting a current of some thousands of amperes from a metal conductor to the massive carbon terminal of a furnace, it was soon found that the existing types of connectors had little value or applicability. The coefficient of expansion of metal is much greater than that of carbon, and the heated gases from the furnace reaction, as well as the heat conducted and radiated from the arc, cause the joint to open a little. At once an increased resistance is introduced at the point or surface of separation, accompanied by a further heating effect, or even by one or several arcs, and the two interacting causes will often combine to entirely destroy the connection. The problems introduced with the large electrodes and heavy currents used in industrial electric furnaces are so novel in character as to have led the German Patent Office to hold that arc light constructions are not to be considered, upon the question of novelty, as against devices performing an analogous office for the electric furnace. Of late a considerable number of devices especially designed for electric furnace work have been designed.

Two patents recently issued (June 18) to Mr. Alfred H. Cowles, of Cleveland, Ohio, cover connectors of forms especially applicable to open and closed electric furnaces, respectively. In the former the carbon rod, which serves as one electrode, is socketed in a metal cup, which in turn is surmounted by a water-tight chamber. An inlet pipe extends through this chamber, and through it a stream of water is projected against that portion of the chamber wall nearest to the carbon. An outlet tube is placed above so that in operation the chamber is filled with water in continuous flow. The furnace shown is of the water-jacketed crucible type, provided with lateral openings for a reversing flow of gas, and adapted to work in connection with a system of regenerators.

The carbon electrode for the closed furnace is connected through a series of interposed metal plugs and pins with a metal conductor bar, and the whole is encased in a vertical sheet metal tube surmounting, but insulated from, the cover of the furnace, the bar passing out through a stuffing box at the top of the tube. Adjustment of the electrode is effected by sliding the carbon in its metal sheath, and access of the heated and corrosive furnace gases to the connection between the carbon and its metal conductor bar is prevented by forcing into the tube above the carbon a neutral gas, preferably a hydrocarbon, and preferably under such pressure as to maintain a slow downward current between the electrode and its sheath, into the furnace.

This furnace is of the class recently described in these columns (May 18), having a crucible electrode of porous carbon, surrounded by a water-jacketed condenser, and especially applicable for the reduction of compounds yielding a volatile element, as sodium or phosphorus. The process then described, involving the reduction of sodium aluminate with simultaneous production of metallic sodium and aluminum carbide or aluminum bronze, forms the subject of a third patent to the same inventor and bearing the same date.

Calcium Carbide from Impure Raw Materials.

Calcium carbide is almost unique among commercial products in that it cannot be refined by any known method. Refining processes have been developed for all of the metals, and for the common marketable chemical products a process of purification is elaborated and adopted as a matter of course. The high melting point of calcium carbide, however, excludes processes involving recrystallization or sublimation, or any such fusion treatment as is applicable to iron, and the metals generally; and its insolubility under all circumstances prevents the application of any of the methods based upon treatment by and separation from solvents. Pure calcium carbide is now produced, therefore, only from pure raw materials, and is of necessity very costly as compared with the lower grades.

On the other hand, it is a comparatively simple matter to produce acetylene of sufficient purity for ordinary use from a low-grade carbide. The calcium hydrate which remains as a residue when the carbide reacts with water is itself an efficient absorbent for hydrogen sulphide, and other gases evolved can be readily absorbed by appropriate reagents. But the necessity for the application of any purifying means, however simple these may be, to the evolved gas, at once takes away from calcium carbide one of its chief advantages over other sources of illuminants, viz., its availability for small and especially for portable generators. It remains therefore as a sole practicable alternative to so conduct the furnace operation as to enhance the purity of the product, either by applying during the reduction or by incorporating with the charge, such agents as will determine the elimination of the more noxious impurities, or will render them inert during the subsequent treatment of the carbide for the production of acetylene.

This is a neglected field of study, but two suggestions to this end being noted in the literature. Hewes has proposed to use a furnace charge consisting of 26 parts of carbon, 64 of lime, 8 of calcium carbonate or limestone, and 2 of peroxide of manganese. From this charge carbides of calcium and of manganese (Mn_3C) are formed simultaneously, the latter acting as a flux to reduce the temperature of the reaction and to increase the fluidity of the product, and serving also by evolution of methane (CH_4) to somewhat dilute the acetylene and hence to lessen its tendency to deposit carbon. The calcium carbonate yields a considerable volume of gas which, bubbling through the molten carbide, is said to mechanically carry much of the sulphide and phosphide of calcium to the surface where it forms an easily removable crust.

The second suggestion is due to Dr. Walther Rathenau, of Berlin, and forms the subject of a patent recently issued (June 18). It is proposed by him, when producing calcium carbide from either lime or coal of high silicic acid content, to incorporate with the charge a metal or compound capable of forming a silicide stable at the temperature of the reaction, in quantity sufficient to unite with all of the silicon present. If iron or iron oxide be chosen the silicide formed collects beneath the molten carbide and may be tapped from the furnace, or afterward detached from the carbide block. Compounds of copper, manganese or chromium will serve the purpose as well as iron, but the latter metal is preferred, not only on account of its cheapness, but because of the many industrial uses which are being found for its conductive and chemically resistant silicides.

Governmental Use of Telephones in Washington.

BY B. C. WASHINGTON, JR.

PROMPTLY at 9 a. m. every week day the work of a "billion-dollar country" is taken up and the busy tinkle of more than a thousand telephone bells is started in the Government's great administrative factories. As is well known throughout the world, in Washington City are located the principal offices of the Government, where thousands of men and women are engaged in transacting the truly enormous business of a "world-power" government.

The tremendous machinery of the Government works as smoothly as a well-balanced flywheel on a Corliss engine. To be sure, there are hundreds of parts to this machinery, yet so well are they organized and operated that there is little lost motion or friction. It is quite safe to say that the telephone plays the most important part of each day's work. Seven of the eight departments, and the larger bureaus of those departments, have private branch exchanges, installed and owned by the Chesapeake & Potomac Telephone Company. In the Capitol are two exchanges, one being in the Senate end and the other in the House end. These exchanges are about 750 ft. apart, so that some idea can be had of the dense volume of business that requires two exchanges and over 150 telephones in one building in order to transact that business. The Library of Congress, the Navy Yard, Pension Office and other large offices named have well-equipped exchanges. The operators of these exchanges are all employed by the Government, and in some cases shifts are employed, so that important exchanges are manned at all hours of the day and night. In a number of cases, where the departments do a large amount of telegraphing, the telephone and telegraph business is put in charge of experts, well experienced in both these branches; and the telephone and telegraph apparatus is placed in one room.

In the Pension Office one man sits in a revolving chair with the telegraph instruments mounted on his desk in front. On his right is the telephone switchboard, and on his left a typewriter. This man has become so expert that he can receive a telegram and typewrite it and give meanwhile proper attention to a busy switchboard. This is an excellent demonstration of the many automatic features possessed by this style of telephone apparatus. Another point well worth mentioning is the compactness of the apparatus, as is illustrated by putting the Senate switchboard in a window recess. It is quite well known, however, that many of the Government buildings in Washington occupy several acres of ground. The Capitol, for instance, occupies over 3½ acres, so does the Library of Congress, while the War, State and Navy Building occupies about four acres. The buildings having private branch telephone exchanges in them cover an aggregate of 30 acres.

Taking into consideration that the departments have been organized with the idea that each department is a distinct and separate branch of the Government, it is easily understood that within such departments there is absolute necessity for a very large amount of inter-communication between the chiefs of divisions. Under the old order of things, personal interviews were held or letters conveyed between the chiefs by messengers. This was slow work and unbusiness-like, and the results were far from satisfactory. Now, under the present up-to-date methods nearly every room of importance is provided with a telephone, and the business of the Government is transacted with expedition. The volume of business transacted through these private exchanges is very large. Taking the estimates of the operators as a basis, the aggregate number of calls independent of central is for the 18 exchanges approximately 6000 per day of seven hours. At the same time, a large aggregate of calls come and go through "central."

At this dull time of the year, during the recess of Congress, the calls average about 2050 per day, but when Congress is in session this is nearly trebled. Then the operators at the Senate and House exchanges receive and send, each through their switchboard, messages at the rate of one a minute, and the department exchanges do a greatly increased business.

Naturally, the question suggests itself, Who does all this telephoning, and what is it about? To explain at length would require a resumé of the entire business of the Government. A short sketch will suffice to throw some light on the nature of the telephone work. At the Capitol the bulk of the work is during the sessions of Congress, and the local work is largely the business of the numerous committees who have charge of the thousands of bills that are introduced in the Senate and House. From the talk on the respective floors of the House and Senate, as evidenced by the *Congressional Record*, it is easily understood how the Capitol telephone wires are kept warm. In the departments and bureaus the telephoning is mostly relative to routine work.

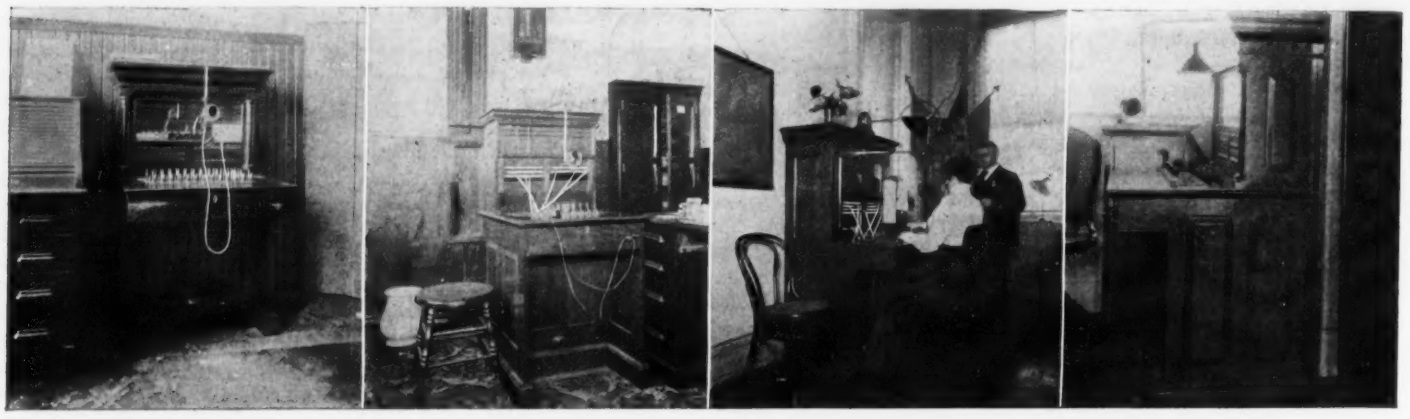


FIG. 1.—POST-OFFICE SWITCHBOARD. FIG. 2.—PENSION OFFICE. FIG. 3.—NAVY DEPARTMENT. FIG. 4.—UNITED STATES SENATE.

TELEPHONY IN GOVERNMENT DEPARTMENTS.

The private exchanges and telephone data concerning them is to be found condensed in the accompanying table:

PRIVATE BRANCH TELEPHONE EXCHANGES OF THE UNITED STATES GOVERNMENT IN WASHINGTON, D. C.

Name of Private Branch Exchange.	Number of telephones in Exchange.	Number of trunk lines.	Number of trunk lines independent of Central.	Approximate number of calls per day through Central on Government account.		
				Out.	In.	Total.
Interior Department	107	4	3	75	33	108
War Department	83	10	.....	122	91	213
Treasury Department	79	7	....	204	114	318
House of Representatives	74	7	3	43	16	59
Government Hospital for the Insane	73	1	.....	20	17	37
Senate	72	9	3	107	31	138
State Department	71	9	.....	160	77	237
Post Office Department	68	4	.....	45	55	100
Government Printing Office	46	4	.....	68	77	145
Department of Agriculture	37	2	.....	46	53	99
Pension Office	20	1	.....	5	10	15
Census Office	28	4	.....	80	40	120
Interstate Commerce Commission	26	2	.....	22	23	45
Department of Justice	25	2	.....	61	51	112
Library of Congress	24	2	2	46	10	56
National Museum	22	2	...	61	39	100
Washington Navy Yard	6	2	.....	35	55	90
War Dept. Q. M. G.'s Office	6	2	.....	23	31	54
Total.	870	74	11	1.223	823	2,046

This data covers only the branch telephone exchanges properly charged to the general Government. There are, in addition to these, a large number of telephones located in the smaller bureaus and departments. With these may be noted the large number of telephones in the use of the city post office, and the branch post offices.

The expenses of the District of Columbia Government is shared by the whole country, Congress, largely on account of the vast untaxable Government properties, paying half the expenses, so that it is readily seen that the United States Government is carrying half the expenses of the District's police, fire, school and city departments, telephones, etc. The aggregate of the Government's and the District's telephones, not included in the table, is about 225 instruments.

In this connection, therefore, it is deemed worthy to give a few details concerning the very excellent apparatus the local telephone company has installed for this service. The Government telephone system, worked on the basis of branch exchanges, is of the central energy type, connected with the main exchange of the company by trunk lines. When a Government employee desires the attention of the operator he simply removes the telephone from the hook, this operation actuates a little signal which is exposed directly in front of the switchboard operator. The operations are thenceforward essentially of the central energy method until the connection has been cleared out and the conversation closed. When the conversation between the two parties is ended the act of restoring either receiver to its hook again actuates the corresponding visual or signal in the cord circuit, and causes it to disappear from the operator's vision, thus indicating that the conversation has been finished. It can be readily told by the operator which one of the parties placed their receiver on the hook first, as there is a visual on the cord circuit, as above explained. This absolutely prevents the necessity of an operator "going-in on the line," and inquiring if the user has transacted his business, or whether he obtained the party wanted, and the many other annoyances and interruptions of service that occurred in the old style switchboard apparatus, such as the departments had previous to the introduction of the central energy system.

Each departmental branch has a complete storage battery plant in duplicate, with a ringing machine for the calling of subscribers, the proper switches, etc., and it is so operated by the Telephone Company that while one set of storage batteries is furnishing the necessary current for transmission, or the signaling of the operator by the subscriber, the duplicate set is being charged ready to supply the necessary current for the next 24 hours. These battery sets alternate, each operating 24 hours. The instruments used are of two styles, the one known as the desk set, is a very neat and handsome nickel-plated piece of apparatus. The other style used is known as the wall set.

Electrical Engineering and Young Men.

Professor F. B. Crocker has the leading article in the *Saturday Evening Post,* of June 22. It is entitled: "The Young Man and the New Force," and discusses in a most interesting and suggestive manner the opportunities and the requirements in the field of electrical engineering. He points out that the profession is one in which young men are peculiarly numerous and predominant, and says that having personally followed the careers of several hundred men, in electricity he is "convinced that they have gone ahead more rapidly than would have been possible in any other line of human effort." One of the reasons for this is that the industry is so new and has expanded enormously, forcing men ahead." The other reason is the fact that electricity is a peculiar subject. In its pursuit general intelligence or knowledge is not sufficient for pronounced success. A man possessing special taste for it soon differentiates himself from the others working alongside who may not be endowed with the same advantages. Such a man will forge ahead of his fellows at a rate that is absolutely impossible in any other calling in the world. The successful electrical engineer has more than mere ability. He is gifted with special talent, like the successful artist or the musician. Electricity is, to my mind, the only mechanical pursuit that has 'soul.' The successful electrician is born. Many of the qualities that are his are intangible, just as the fine musician's qualities are. But there must also be tangible qualities, certain fixed mental traits. He must have great mental alertness; the ability to think quickly, to grasp a given situation at once. He must be of an analytical turn of mind—that is, able to reason from cause to effect, or vice versa. In electricity one thing follows from another with absolute certainty."

While admitting the fact that electricity is more or less of a marvel in spite of its exactitude, Professor Crocker criticises the popular idea that electricity remains unknowable. He contends rather that the proper attitude of the electrical worker is that of willingness to accept innovation, and not of prejudice against it. "It is the first duty of an electrical worker to fall in with rapid advances and radical departures. Therefore, a necessary qualification for the successful electrician is an interest in things that are new *because they are new.* Any one with a strong conservative tendency would be at a disadvantage in the electrical field. This is probably the reason why Americans have got along faster than any other nation in the development and use of electricity. An American prefers a thing that is new, whereas a foreigner considers newness in itself an objection. The man who is interested in ancient literature, or in archæology, cares little for electricity. This is a fact I have observed among my own friends. Those who have gone into electricity with the idea of saving themselves labor have made a great mistake, because electricity requires fully as much application and intensity of purpose as any other lien of work."

After arguing for the value of technical training and its results, as shown by the preference given to electrical engineers who have graduated from a college or technical school, Professor Crocker remarks: "Of course, success is a somewhat relative term, and it is rather hard to say what proportion of men succeed, as success may be measured in various ways. But it is probably fair to say that nearly all electricians make a good living within a year or two after they graduate. It is probably a fact that at least half of the men make what can be called a substantial success within three or four years after graduation. I have in mind several young men who have reached prominent positions, and won a national reputation in their profession, within five years after graduation from Columbia University. One of them is chief electrical engineer of the Niagara plant, the largest in the world. Another is professor of electrical engineering in a prominent university. Another became chief engineer of a well-known manufacturing company in less than two years after graduation.

"But though these men and many others have done exceedingly creditable work and now fill responsible positions, it is a fact that the pay is not as large in the technical branches as it is in the administrative departments. This is true, however, in all other human pursuits. The technical men in a railway, for example, receive much smaller salaries than the executive officers. The same is true in chemical industries, and in many other lines. There is no more responsible position, or one requiring more knowledge or skill, than that of captain of a transatlantic liner, and yet his pay is comparatively small. The presidents of the steamship companies, with nothing like such direct responsibility, receive salaries 10 or 20 times greater than those of the captains of the vessels. By the technical man, $5,000 a year would be considered a very good and $10,000 an exceptionally large salary. There is one thing to be considered, however. In the logical development of the new business scheme that is controlling all our great corporations, technical knowledge is beginning to be more and more to the advantage of the men who seek the great positions in these corporations. As the years go by the demand will certainly become steadily greater for a class of men who combine executive ability with a thorough technical understanding of the work they are called on to supervise. Already we have a number of striking examples of technical men who have won great business positions."

Professor Crocker sees few limitations to the growth of electrical industry, and believes that most lines of manufacture and transportation are becoming dependent upon it.

Rectifier for Polyphase Alternating Currents.

The June number of *Tuft's Engineer* contains a paper by Lewis H. Haynes on "A Rectifier for Polyphase Alternating Currents." The rectifier described is for two-phase currents. Each phase has a separate two-part commutator with two collecting brushes on each side, the object of the auxiliary brush being to enable the length of time each phase is short-circuited to be varied, as there is a certain interval in which there is minimum sparking. The shaft carrying the two-part commutators also carries four rings connected with the two-phase circuit, these rings being joined to the respective parts of the commutators. The conclusions drawn from the experimental rectifier are that it is perfectly feasible and practical to build a rectifier for commercial arc lighting to operate at voltages as high as 7000 or 8000, and that from an economical standpoint such a rectifier is desirable.

A Missionary Electrician.

BY PROFESSOR W. H. HALLOCK.

AMONG the honorary degrees conferred by Columbia University at its annual commencement June 12 was that of Master of Science conferred upon Mr. F. D. Gamewell. It is, perhaps, unusual that the conferring of an honorary degree should be of special interest to electrical engineers, or that the honoring of a missionary should call for special mention in a technical journal, but Mr. Gamewell certainly deserves this recognition.

Some six years ago, when Mr. Gamewell spent the winter in New York preparing to enter upon his duties as Professor of Physics in the University of Pekin, he was offered $500 to buy an electric light plant for the mission house and laboratories. Mr. Gamewell naturally discovered that this amount would go but a little ways towards purchasing the engine, dynamo and fittings. Indeed, the first estimate which was made for him as to the price of the simplest outfit that would pay for the trouble of installation was about $1,400. Mr. Gamewell's missionary ability was exhibited nowhere more forcibly than in his success in bringing down the electric supply company and bringing up his donor until they finally met, and he was enabled to take with him a very satisfactory plant adapted to supply about 150 incandescent lamps. His engineering ability was exhibited in his ingenuity in planning the distribution of material in the plant and providing everything for its equipment, and making himself sufficiently familiar with all the details so that he would be able to install it with the aid of native labor. Mr. Gamewell did install his plant at Pekin and operated it successfully to the unbounded amazement of the natives. It was, I believe, the first electric light plant in Pekin, outside of the Imperial Palace.

It seemed at one time as if disaster was certain, inasmuch as the means of transportation between the seaport and Pekin were such that the heavy castings and armature of the dynamo were unceremoniously dumped upon the bank of the river to lie there for a week or ten days before he accidentally got track of them and ultimately transported them to the city. Not content with surprising the natives with the sudden brilliancy of his electric illumination in the chapel, he introduced the laboratory method of teaching physics into China, and even translated into Chinese the instructions for performing the ordinary laboratory experiments. Unfortunately, this Chinese manuscript was lost in the conflagration which wiped out the electric light plant, the mission house and the whole university. He often refers to the strangeness of attempting to convey to the Chinese mind the operation and principle of such instruments as the galvanometer, Wheatstone bridges and such things. One can scarcely imagine how Ohm's law would look when translated into Chinese.

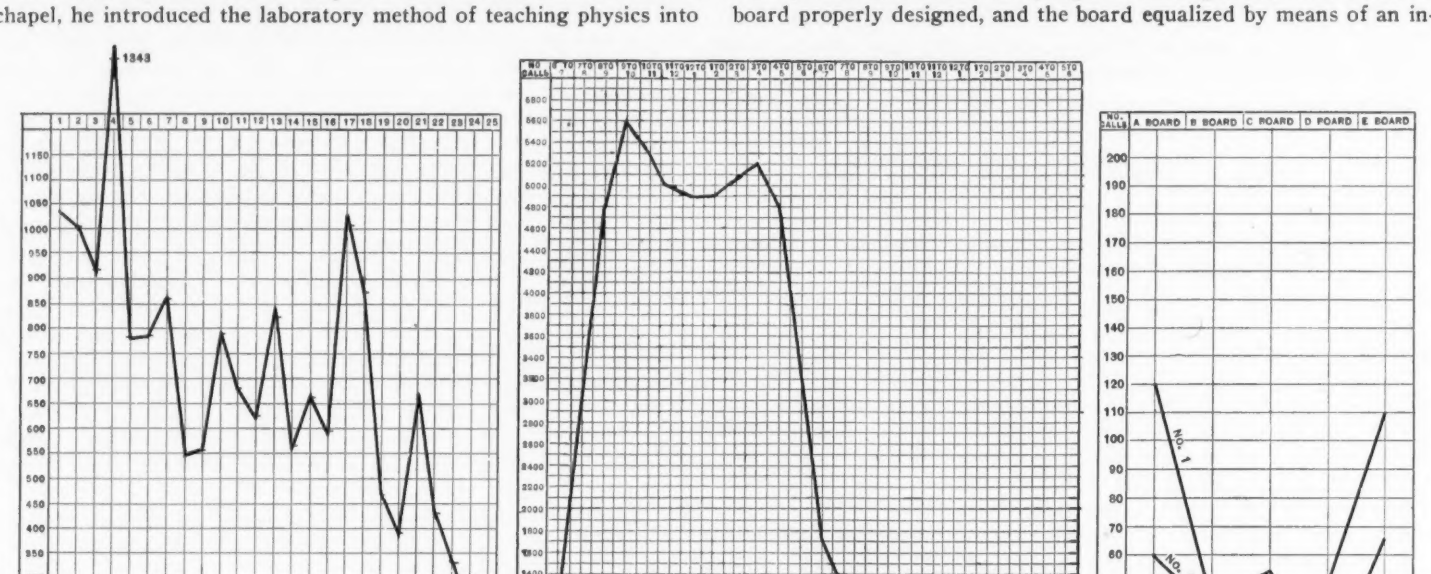
When it is remembered that Mr. Gamewell was trained as a missionary of the Methodist Episcopal Church and served in Western China in that capacity for 10 or 15 years, the full importance of his engineering feats will be appreciated. Beside establishing a physical laboratory and electric light plant and building a mission house on the American plan with native labor, in spite of the fact that foreign engineers declared that he could not, Mr. Gamewell placed the final capstone upon his engineering accomplishments by constructing a system of defences around the legations in Pekin, which military engineers have declared could not have been improved upon by Todleben himself.

Telephone Load Diagrams.

In the course of his paper read recently before the Independent Telephone Association at Buffalo, Mr. L. W. Stanton, of the Cuyahoga Telephone Company, Cleveland, referred to the results of some "peg count" tests which he exhibited in diagrams. The subjoined are his data in detail, now furnished in regard to the diagrams:

In chart No. 1 we have the load curves showing the number of calls answered by each operator. The numbers 1, 2, 3, etc., along the line at the top of the chart, designate the operator's position. The figures in the vertical column at the left, designate the number of calls answered in 24 hours. The heavy black line, where it crosses the operator's position line, designates the number of calls for that operator's position for 24 hours. For example, the heavy black line, or index line crosses the line representing position No. 1 at approximately 1040, which is the number of calls answered at that position during 24 hours. Position No. 2 answered during 24 hours 1000 calls; position No. 3, 910 calls; position No. 4, 1343 calls, etc.

The above chart is not imaginary, but one accurately compiled from an exchange of 1563 subscribers, and the number of calls is slightly over 17,000 in 24 hours, which gives an average of 10 and a fraction calls per telephone. While this exchange is being operated by 25 operators, they are not giving as prompt and efficient service, on a whole, as would be obtained by eight or nine operators with a switchboard properly designed, and the board equalized by means of an intermediate, or cross connecting board. By the use of an intermediate board in connection with a multiple switchboard, the subscriber's line signal and answering jack may be shifted in front of any operator, without changing the subscriber's telephone number. In this manner the busy lines which are generally located in front of the first few operators may be shifted in part to one of the operators who has mostly residence telephones, and in turn some of the residence telephones should be shifted in front of the operator who has all business telephones. In this way each operator may be given approximately the same number of calls for the 24 hours, which should



FIGS. 1, 2 AND 3.—TELEPHONE LOAD DIAGRAMS.

be practically 2000. This would mean that during the busiest hour she would answer approximately 250 calls.

It has been found through hundreds of tests that one-eighth of the number of calls answered during 24 hours is approximately the number answered during the busiest hour. Two thousand for 24 hours, 250 of which are answered during the busiest hour, is not excessive for any ordinary operator; in fact, there are many operators who are handling busy positions that are answering considerably in excess of this number. In one case, the writer knew of an operator answering 528 calls an hour, and in another case of a trunking operator handling 1248 calls per hour. This is excessive, and cannot be continued but a short time, but an operator answering from 200 to 250 calls per hour on a modern switchboard is not excessively busy, and with good team work among operators they can give better than four-second service. Operators without exception prefer the busy positions, and the operators who answer the fewest calls are invariably the ones who give slow service.

Chart No. 2 shows the necessity of distributing the business and residence telephones in front of the operators. In this chart the vertical column shows the number of calls answered per hour, and the horizontal heading at the top shows the different boards. *A* board has all busy telephones, while *B*, *C* and *D* boards have about the same number of each business and residence telephones, while *E* board has all residence and farmer line telephones. Index line No. 1 designates the number of calls answered by each operator during the hour from 8 to 9 in the morning. The operator on *A* board answered 120 during this hour, while the operator on *E* board answered approximately half this number. Index line No. 2 shows the number of calls answered from 11 to 12 a. m., and during this hour the *A* operator has answered about half what the *E* operator answered. This will be seen to be a complete reverse from what it was during the hour from 8 to 9, or, in other words, one operator is idle while the other is busy and vice versa. In this exchange, with a proper switchboard, and the load equally distributed, two operators could answer all the calls, and give first-class service.

Scores of peg counts taken among the independent telephone companies show that 10 and a fraction calls per telephone are the average. Taking these figures as a basis, it will require 200 subscribers per operator to give an average of 2000 calls for each position for 24 hours. This number would be excessive if they were party lines with four or six parties on a line, or if they were all business lines like we find in some downtown branch offices, which have no residence telephones to reduce the average number of calls per telephone, or in an exchange where a large per cent of the calls have to be trunked to another exchange, in which case the trunking consumes more of the operator's time than is required where connections are made direct in the multiple.

Chart No. 3 shows the number of calls answered per hour for 24 hours. A chart similar to any one of the three can easily be made after taking a count of the number of calls answered by each operator during each of the 24 hours. The calls may be tallied with a pencil and paper or by moving a peg from one jack to another, or, best of all, by using the tally register made by Jas. O. Benton, of New York.

Pacific Coast Electric Transmission Association.

The fifth annual convention of the Pacific Coast Electric Transmission Association was held at the Hotel Vandome in San Jose on June 18. Forty members from various parts of the State were present. Prince Andre Poniatowski, of San Francisco, president of the association, presided, and George P. Low acted as secretary. Papers were read by Louis A. Hicks, T. E. Theberath, C. A. Poole, C. E. Dutcher and A. G. McAdie.

Officers were elected as follows: President, Dr. C. W. Van Norden; vice-president, E. J. Desable; treasurer, William Angus; secretary, George P. Low, all of San Francisco. Dr. Van Norden, John Martin and H. H. St. Clair constitute the new executive committee.

On the evening of the 19th a banquet was given to the visiting members at the Hotel Vendome. On the following day the members of the association were guests of the Electric Improvement Company, of San Jose. Special cars were provided to carry the members to the different points of interest in the city.

On the day that the convention met in San Jose, the street cars in that city began to be operated by power generated 184 miles away. The current was transmitted on the wires of the Standard Electric Company, and will be hereafter used in operating all the street cars of the city.

Pan-American Electrical Exhibitors.

The exhibitors and exhibitors' representatives at the Electricity Building of the Pan-American Exposition held a meeting Tuesday evening, June 18, at the office of Professor G. F. Sever, superintendent of electrical exhibits for the purpose of forming an organization for mutual benefit in a business and social way. Officers were elected as follows: F. W. Hurlbert, of the General Electric Company, president; W. M. Probasco, of the Westinghouse companies, vice-president; W. Jac Marland, curator of the collective exhibit, secretary; W. H. Markgraf, of the Edison Manufacturing Company, treasurer. The question of a name for the organization elicited considerable discussion and suggestions varied all the way from "The Pan-American Electrical Exhibitors and Electrical Exhibitors' Representatives Society" to "Pan-Electric Club." The matter was finally left to a committee. The organization will probably meet for a few minutes once a week on Monday evenings.

New Canadian Power Scheme.

An order-in-council, passed by the Ontario Government, authorizes the Niagara-Welland Power Company to commence work. The company's plan is to tap the Welland River, east of the canal, and by means of a cut to carry the water of the Niagara and Welland Rivers to the high bluff near the city of St. Catherines, Ont., where a fall of over 180 feet may be obtained, and thence waste into Lake Ontario. This route also gives three other falls of 33 feet and 56 feet below the bluff, or a total fall of about 300 feet. The capacity of the waterway will be over 100,000 water horse-power, which at the first fall will produce over 75,000 electric horse-power at the wheel, still leaving three falls for later development. There would be a primary installation of 30,000 electrical horse-power, a large part of which the company hopes to transmit to Toronto, the balance to be utilized at St. Catherines.

CURRENT NEWS AND NOTES.

MAIL TUBES.—Mail-tube service in New York City, failing an appropriation by Congress, will be discontinued on July 1, and the distribution of mail matter will therefore be slower than it has been in the last two or three years.

IMPROVING SUBMARINE BOATS.—The *Petit Parisien* says that the new French submarine boats building will be furnished with double motors, steam and electricity, similar to the fittings of the Holland, thus increasing their sphere of action and enabling them to plunge quicker than the Narval. The latter's recent experiments were unsatisfactory. The crew suffered greatly, and navigation on the surface was also defective.

CONNECTICUT TROLLEYS.—It is stated that during the recent session of the General Assembly not less than 50 special acts relating to street railways were passed. As the result of franchises that were granted a large number of interurban trolley lines will be built. Connections will be made between Hartford and Springfield, Derby and New Haven, Waterbury and New Haven, Meriden and New Haven, Middletown and Meriden, and Rockville and Stafford Springs. The present tendency in the trolley development of Connecticut is toward the construction of trunk lines.

GOVERNMENT TELEGRAPH SCANDAL.—A cable dispatch from London of June 22 says: A betting scandal has been discovered this week in the Government telegraph department. Operators in the central office in London have been in league with others in suburban and provincial offices for swindling bookmakers. The methods adopted have been ingenious, elaborate and successful and included a resort to forgery. About a score of men have been suspended, preliminary to their dismissal, and an exhaustive inquiry is now proceeding with a view to ascertaining the exact extent of the evil. The present intention is to institute criminal proceedings against the ringleaders.

HIGH-FREQUENCY ALTERNATOR.—The June number of *Tuft's Engineer* describes a high-frequency alternator designed by Professor W. L. Hopper and constructed by the electrical engineering students of the classes of '98 and '99 of Tuft's College. The alternator is of the Mordey type, and has 12 sets of coils, 4 in series. Each set of coils has outer terminals, and the coils can be arranged in series, in multiple or in any combination of multiple series. With all the coils in series the machine gives from 7 to 10 amperes at 100 volts. The machine is intended to run at a speed of 1250 r. p. m., at which it will give a periodicity of 1000.

LUCANIA'S WIRELESS TELEGRAPH.—The Cunarder Lucania, in on Saturday from Liverpool and Queenstown, experimented with the Marconi system of wireless telegraphy on her voyage to this port. Going down the Mersey she exchanged aerial greetings with the British schoolship Conway, which is equipped with the Marconi apparatus. She also exchanged salutes with wireless-telegraph stations on the Irish coast, and while at sea with the Elder-Dempter liner Lake Champlain, also fitted with a wireless system of communication. Many passengers sent messages to their friends ashore by way of the stations on the Irish coast.

ELECTRO-CHEMISTRY AT THE UNIVERSITY OF WISCONSIN.—The University of Wisconsin has a course in applied electro-chemistry extending over four years. During the first two years the course is identical with that of the electrical engineering course, and in the final two years in a number of studies is also identical with the latter course. The instruction in electro-chemistry and electro-metallurgy is given by Professor C. F. Burgess. The list of branches as they appear in the bulletin of the University are: 1. Primary and Secondary Batteries. 2. Electrolysis and Metallurgy. 3. Applied Electro-Chemistry. 4. Electricity as Applied to the Treatment of Metal Surfaces.

PRESENTATION TO PRESIDENT McKINLEY.—Mr. Chas. H. Baker, president of the Snoqualmie Falls Power Company, of Seattle, Wash., on June 21 presented to President McKinley at Washington a gold and silver plate valued at $500, the gift of the Power Company. The President and the Cabinet would have visited the falls on the occasion of the projected tour to the Pacific Northwest had not Mrs. McKinley's illness prevented the trip north of San Francisco, and the plate was to have been presented there. On the plate are elaborately wrought pictures of scenes surrounding the falls and industrial plants in Seattle and Tacoma, supplied by the falls' power. Mr. Baker told the President that every wheel in Seattle and Tacoma, including the street cars in both cities, is turning by electric power from Snoqualmie Falls.

FRENCH ELECTRICAL ENGINEERS TO VISIT THE UNITED STATES.—Our Paris contemporary, *L'Eclairage Electrique,* is organizing a technical excursion to the United States to visit the Pan-American Exhibition in Buffalo, and to attend at the same place the convention in August of the American Society of Electrical Engineers. The party will leave Paris Aug. 3, arrive at New York, Aug. 11, and leave for Philadelphia the same day. Aug. 13 will be spent in Washington, and the party will remain in New York from the 14th to the 18th. The programme from the 18th to the 26th coincides with that of the American Institute of Electrical Engineers. From Buffalo the party will go to Chicago, and from that city by way of the Lakes and the St. Lawrence River to Montreal and Quebec, returning to New York Sept. 3, and sailing from the latter city Sept. 5.

A PROPOSED TELEGRAPHIC CODE.—In a paper read at the recent Buffalo meeting of the Railway Telegraphers' Association, Mr. C. S. Rhoads discussed in a paper the subject of cipher codes for railroad telegraphing. In conclusion, the desirability of a code for the use of presidents, general managers and general superintendents was suggested. As an illustration of the use of such a code the paper says: "Just imagine what a saving in time of both the wire and the clerk (or even official) to have, for instance, instead of 'Yes, we had a delightful time at the theater last night; that ice cream was immense; but I didn't like the way you made "goo-goo" eyes at that blonde waiter one bit,' the one word 'Quack.' Then the reply, 'Oh, don't say a word—I overslept myself, got to the office an hour late this morning and couldn't get down to business until I'd called you up—don't mention blondes—your black sparklers are good enough for me. Will be around again to-night. The "old man" is waiting to use the 'phone—so long'—all contained in the one word 'Smack.'"

WATER-POWER COSTS IN AUSTRIA.—Mr. Frank W. Mahin, United States Consul at Reichenberg, reports as follows: During the consideration of the subject of water power, at a recent meeting of the Lower Austrian Industrial Union, figures were produced and instances cited to prove that water power was cheaper to establish and much cheaper to operate than steam power. The following test case in the Tyrol was mentioned: A factory was equipped with both water and steam power, of the same volume. The first cost 1.60 florins (65 cents) per horse-power and the latter 1.80 florins (73 cents). In the cost of operating, however, the difference was great. With water, the expense was 0.174 kreutzer (0.07 cent) per horse-power per hour; with steam, 1.266 kreutzers (0.61 cent). The saving in a year by the use of water amounted to 502,000 florins ($203,812), representing in Austria a capital of 10,000,000 florins ($4,060,000). Another Austrian water-power plant mentioned operates an electric plant which lights a town 11 miles distant. Power is also cheaply supplied to several neighboring factories. This plant was established in 1897, and the effect has been to give renewed industrial life to that locality. Its operating cost is 0.16 kreutzer (0.065 cent) per horse-power per hour. Other instances were also given, among them that of a water motor of 15,000 horse-power now being erected. This will operate a number of factories, several of which are at present under construction. The price charged will be 80 crowns ($16.24) per year per horse-power.

LETTERS TO THE EDITORS.

Wireless Telegraphy.

To the Editors of Electrical World and Engineer:

Sirs.—In a letter on the above subject published in your journal of June 22, 1901, I notice that the rectilinear propagation of electric waves such as are used in wireless telegraphy, is said not to agree with experiments. It is there stated that "If this radiation does not go through, it must go around, etc." This conclusion does not appear to be at all necessary, as the ascending vapor, more especially that over water, is continually being condensed above, on account of the colder air in the upper regions, clouds visible and invisible are being formed, and these clouds would reflect the waves in a multitude of directions, but always away from their source; the initial angles of incidence and reflection being always equal, there would, in addition, be secondary sources formed. It can thus readily be seen that the rectilinear propagation of electric waves is not at all disproved by such experiments.

BALTIMORE, MD. ALFRED G. DELL.

Litigation on Telephone Switchboards.

To the Editors of Electrical World and Engineer:

Sirs.—I have been asked to make a statement with reference to the decision of Judge Marshall sustaining the Seely patent in the suit of the Western Electric Company against the Kinloch Company at St. Louis.

The Kinloch switchboard was the first switchboard manufactured by the Kellogg Switchboard & Supply Company. It was begun in the year 1897 and finished the next year. It was not considered by us that the board would infringe the Seely patent, and it is only by the most favorable construction of the patent that it can be considered to do so. For instance, the claims have as elements, in addition to the multiple jacks, additional or answering jacks arranged in "uniform groups." Judge Marshall's opinion is to the effect that in the Kinloch board there is not an "actual uniformity," but only an "*apparent* uniformity" or a "uniformity apparent to the eye," to quote from the Judge's decision.

Learning in the year 1898 that the Western Electric Company claimed that the Kinloch board infringed the Seely patent, we from that time changed the construction of our switchboards so that it could not be claimed that they infringed the patent, even "apparently." All the multiple switchboards which have been constructed by our company, excepting the Kinloch board, which was of the date of 1897, have been constructed with this point in view.

The whole matter is one of minor importance, and the victory a

barren one. The case will be appealed, and should the Appellate Court decide that the patent is a valid one and is infringed, certain changes would be easily made in the board, which would remove all claim for infringement. Such changes would not affect in the slightest the efficiency of the service of the Kinloch Company, nor the cost of the operation of the Kinloch plant.

Our Company is a believer in patents and intends to respect all valid or apparently valid patents. It has in the past and is continuing in the policy of investing large amounts in inventions and patents. We are, for this reason, inclined to look upon Judge Marshall's decision sustaining the Seely patent and giving to it a very liberal construction as a "blessing in disguise" to ourselves as a large owner of patents and patent rights.

CHICAGO, ILL. MILO G. KELLOGG.

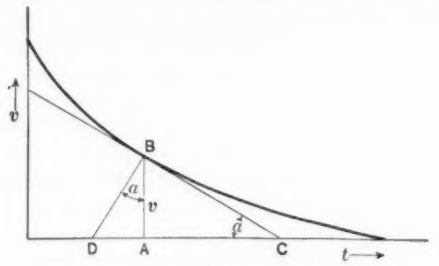
DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS. MOTORS AND TRANSFORMERS

Measuring the Losses in Dynamos.—PEUKERT.—Dettmar has shown that the friction loss in a dynamo can be found by running it as a motor, stopping the supply current to the armature and for the excitation of the field, and measuring the gradual decrease of speed. The loss by friction in a certain time is proportional to the difference of the squares of the speeds at the beginning and at the end of this time. For measuring the speed the remanent magnetism of the machine may be used to advantage, if by a precedent test with a voltmeter the dependency of the e. m. f., generated in the armature, upon the speed is determined. The speed is then, so to say, measured by the voltmeter. The results of the main test may be plotted in a curve, in which the ordinates represent the speed and the abscissas the time. The present author shows that this method may be used also for determining the total loss in the armature when the supply current is interrupted, while the field magnets remain excited. The decrease of the kinetic energy in the armature, which is determined by measuring the decreasing speed, represents the total loss in the armature by friction, eddy currents and hysteresis. He describes a test in which he has determined the total loss and the value of the single losses of a motor by this method.—*Elek. Zeit.*, May 9.

KUHLMANN.—A communication referring to the above article of Peukert. He modifies slightly the theoretical considerations of Peukert and develops a formula which is more exact than that of Peukert. He also shows how the different losses may be determined separately by this method.—*Elek. Zeit.*, May 23.

BLOCH.—A communication referring to the article of Peukert. He describes an interesting graphical method for determining the friction loss per second by Dettmar's method. The adjoining diagram shows Dettmar's curve; the abscissas represent the time and the ordinates



DETTMAR'S CURVE.

the speed of the armature; the curve shows the decrease of speed when for $t = 0$ the current supply and the excitation of the field are interrupted. The present author shows that the friction loss per unit of time is directly proportional to the speed multiplied with the first time differential quotient of the speed, and that it can be directly measured by the length of *A D* in the figure. *B C* is a tangent to Dettmar's curve, *B D* is perpendicular to *B C*, and *B A* perpendicular to *A C*.—*Elek. Zeit.*, May 30.

Modified Induction Motor.—GROB.—A reply to the criticism of Osnos (Digest, May 11). He remarks that it is not fair to consider his motor as a special case of a synchronous motor. He discusses at some length the influence of a difference of the winding numbers in stator and rotor. Such a difference has an effect analogous to straying. He claims that his motor is at least as efficient as the ordinary induction motor.—*Elek. Zeit.*, May 9.

REFERENCES.

Voltage Drop in Polyphase Alternators.—REY.—A long, illustrated, mathematical article on the predetermination of the voltage drop in the armatures of polyphase alternators, based upon Blondel's "theory of the two reactions." His theoretical results were found to agree well with actual measurements.—*L'Ind. Elec.*, May 25.

Synchronous Motors and Alternators in Parallel.—RUSSELL.—The first parts of what promises to become a long series of "notes on the theory of synchronous motors and of alternators in parallel." He investigates the effect on the difference of two machines in parallel. He discusses the fundamental equation of a synchronous motor. The article is well illustrated with diagrams.—Lond. *Elec. Rev.*, May 31, June 7.

Modified Induction Motor.—BAUCH.—A brief criticism of a special point in Osnos' communication (Digest, May 11).—*Elek. Zeit.*, April 18. A longer reply by Osnos to this criticism in *Elek. Zeit.*, May 9. A reply by Bauch to the latter communication in *Elek. Zeit.*, May 23.

Synchronous Converters.—H. S. MEYER.—A French translation of his long illustrated article on the calculation of synchronous converters, mentioned in the Digest, May 4.—*L'Ind. Elec.*, May 10.

LIGHTS AND LIGHTING.

Lightship Equipment.—An illustrated description of the electric equipment of lightship No. 72. There are two generating sets, each of 8½ kilowatts. The principal office of the ship is to show powerful masthead lights as a warning to navigators. These lights are flashed by a device attached to each generator at the commutator end. This device consists essentially of a circuit breaker, revolving on a horizontal shaft, set at a right angle with the generator shaft. The disks of the circuit breaker are three in number, 4.5 inches in diameter, on a shaft seven-eighths inch in diameter. This shaft carries a worm gear, with 138 teeth, which engages a worm revolving with and being practically a continuation of the generator shaft. The frame containing the bearings for the shaft of the circuit breakers is fastened to the outboard pedestal of the generator by a single plane, thus allowing the worm gear to be engaged or disengaged at will. The three disks have a speed of 2 r. p. m. On the outer surface of one disk are copper strips whose length determines the duration of the flash or time the lamps are illuminated. Two resistance coils, one for each generator, are connected in series with the masthead lights and the circuit breaker, so that when the lights are on, the resistance will not be in the circuit, but the instant the lights are turned off this resistance is at the same instant automatically turned on, thus providing a steady load on the engines. On each mast there are three incandescent lamps of 100 cp and 100 volts.—*West. Elec.*, June 15.

POWER.

Keeping the Angular Variation of an Engine Within a Fixed Limit.—ASTROM.—An abstract of a paper read before the Amer. Soc'y of Mech. Eng. on the "Determination of the flywheels to keep the angular variation of an engine within a fixed limit." He shows that the weight of flywheels on compound engines may generally be greatly reduced by placing the cranks of the two engines at an angle other than 90 degs. or 180 degs. By using the crank angle which gives the most uniform rotative effect, the displacement of crank pin has been found to be reduced by 15 to 30 per cent. Then the engine has not the greatest possible starting power, but this is not, as a rule, essential with engines requiring a very close regulation. In large engines, the reduced cost of the flywheel will cut some figure, but the greatest advantage is gained in those cases where in order to obtain a high degree of regulation the speed of the flywheel rim approaches the allowable limit, when the required regula-

tion can be obtained with a wheel of the same weight but of a considerably reduced diameter.—*St. R'y Rev.*, June 15.

Engines for Parallel Operating of Alternators.—TRINKS.—A paper read before the Engineers' Soc'y of West. Penna., on "The parallel operation of alternators from the engine builder's point of view." He first discusses with the aid of diagrams and mechanical analogies, the reasons of hunting. He shows that the successful parallel operation is almost entirely a question of uniform rotative speed of the engine. He discusses at some length the influence of the engine governor. He speaks of the use of heavy flywheels for reducing the fluctuations in speed, but says that they are unable to keep the speed variations that result from hunting governors or imperfect valve gears, within reasonable limits. He prefers three-crank engines to two-crank or single-crank engines, because they give a more uniform turning moment, and therefore do not require excessively heavy flywheels, provided that the angles between the cranks have been so determined as to give the best results. The valve gear should receive the most careful attention. Undue governor oscillations call for the use of adjustable friction brakes or oil dash pots, and for a good drop of speed between no-load and full-load; or, in other words, a high degree of stability. A governor of small stability is much more liable to hunt than one of higher stability. He discusses the relative advantages of a friction brake or oil dash pot for damping the governor oscillations. He discusses the different methods of paralleling. —*Power*, June.

Steam Turbo-Alternator.—EWING.—A report, with tables and diagrams, on tests on 500-kw Parsons steam turbo-alternator. The machine is a compound turbine of the parallel flow type, running at about 2700 r. p. m., and governed electrically to give constant volts with its shaft directly coupled to the armature of a four-pole alternator, generating 250 amperes at 2500 volts. The exciter armature is on a prolongation of the same shaft.—Lond. *Elec.*, June 7.

REFERENCE.

Steam Turbine.—KUEBLER.—A brief communication giving a diagram, which is the result of a test made to analyze the no-load power of a steam turbine.—*Elek. Zeit.*, May 9.

TRACTION.

Polyphase Plant for Traction.—EBORALL.—The first part of an article on "Polyphase generating and sub-station plant for electric traction." He refers to a recent statement of Hobart, that for electric traction work of an extended character, where converting sub-stations are necessary, the use of rotary converters is a mistake and synchronous motor generators should be used instead. The present writer does not agree with this view, as lighting work is not in question, but simply power work, and therefore the great advantage of synchronous motor-generators, namely, of excellent pressure regulation very simply attained, hardly comes into consideration. He believes that the present good modern practice is the correct one, and he summarizes its features in the power station, the feeder network, the sub-stations and in general. Sub-stations should each have a complete rotary converter equipment. "Air blast (not oil cooled) step-down transformers, with duplicate blower equipment. If underground feeders, the winding on both sides to be star connected, with middle point of primary windings well earthed; if overhead feeders, the windings to be mesh connected on both sides, unless the pressure between line conductors exceeds 10,000 volts. Each rotary converter to have its own step-down transformers, arranged with six-phase connection."—Lond. *Elec. Rev.*, June 7.

Wigan Corporation.—A well illustrated article on the Wigan Corporation Electric Supply & Tramway Works. The permanent station has just been started and a short length of tramway has been inaugurated. The plant promises to grow into a large and important municipal undertaking. The equipment is entirely on the continuous current system, with boosters and balancers, for feeding on the two-wire system and distributing on the three-wire system, with battery regulation. The capacity of the four dynamos installed at present is together 720 kilowatts.—Lond. *Elec.*, June 7.

Size of Wheels for Automobiles.—LUXENBERG.—An article on the influence of the size of the wheels upon the power consumption of an automobile. Three different formulas have been developed. One states that the specific resistance of the rolling friction is inversely proportional to the cube root of the square of the wheel diameter; the second formula states that it is inversely proportional to the wheel diameter; the third that it is inversely proportional to the square root of the wheel diameter. It is probable that all these formulas are valid only under special conditions. He discusses experimental data of Morin, which show that the first of the above formulas is correct only to a very limited degree, and gives entirely wrong results in many cases.—*Centralblatt f. Accum. und Elem. Kunde*, June 1.

REFERENCE.

Return Currents of Electric Railways—KROHN.—A reply to the criticism of Jastrow. He claims that his measurements are correct. —*Elek. Zeit.*, May 16.

INSTALLATIONS. SYSTEMS AND APPLIANCES.

Tynemouth.—An illustrated description of this new British lighting and traction plant. There are two direct-current dynamos, each of 180-kw for lighting and a 190-kw dynamo for traction; 800 lamps of 8 candle-power are connected to the mains at present.—Lond. *Elec. Eng.*, June 7.

REFERENCES.

Rotherham.—An illustrated description of this new British plant. The three-wire direct-current system is used with a pressure of 230 volts at the consumers' terminals. The present plant has a capacity of supplying 4000 to 5000 lamps at one time.—Lond. *Elec. Eng.*, May 31.

Ilford.—An illustrated article on electric lighting and traction at Ilford, near London. The lighting plant has been completed, but the traction plant is still under construction. The plant contains at present three direct-current dynamos of together 500 kilowatts. There is also a battery of a capacity of 600 ampere-hours when discharged at a rate of 200 amperes in three hours.—Lond. *Elec. Rev.*, June 7.

Switch for Charging Storage Batteries.—JOSEPH.—A brief description of a simple switch for making connections with a storage battery for charging. The battery is divided into three equal parts, and two parts are charged at the same time from the supply network. The switch enables one to charge with the first and second part, or the second and third part, or the first and third part, or all three parts at the same time.—*Elektrochem. Zeit.*, June.

Automatic Regulating Switch.—KRAUSSE.—An illustrated description of a new and simple automatic switch to be used for automatically regulating the number of cells of a storage battery or as an automatic shunt regulator for keeping the voltage of a dynamo constant. —*Elek. Zeit.*, May 9.

WIRES, WIRING AND CONDUITS.

Copper Required in the Three-Wire System.—FINZI.—A communication referring to a statement that the copper required in the three-wire system, with a middle wire of the same thickness as the outers, is 37.5, if the copper required for the two-wire system is 100, provided that watts, losses, voltage and distance are the same in both cases. In this statement one of the most important points for lighting installations, namely, "the elasticity of the system," is not taken into account. At constant voltage between either outer and the middle wire at the beginning of the line, and for equal per cent of voltage variations at the lamps, the copper required depends upon the possibly occurring difference of load on both sides of the system and varies between 37.5 and 112.5. The value 37.5 corresponds to the most favorable case, in which the load is equally distributed between the two halves of the system. The value 112.5 corresponds to the most unfavorable case, in which the difference of the loads of both halves may have any value.—*Elek. Zeit.*, May 9.

ELECTRO-PHYSICS AND MAGNETISM.

Induction Coils for Spark Discharges.—KLINGELFUSS.—An account of a demonstration before the German Electro-Chemical Society of two induction coils, one with a straight iron core for sparks of 1 meter length, the other with a closed iron core for discharges of 35 cm. length and of the thickness of a finger. The first one has two entirely separate primary windings, one having 140 turns for electrolytic interrupters, the other having 800 turns for mercury interrupters and for single discharges. The secondary winding has 86,000 turns, and has been wound by a special method. The voltage at the discharge poles was found to depend upon the form of these poles, especially upon the condition whether the positive pole was more or less pointed. The voltage for a given spark length was also found to depend upon the more or less strong magnetic field. With the same discharge poles and the same capacity of the condenser in shunt with the spark-gap, he found the following maximum voltages required for spark discharges of varying length: 107,500, 268,-

800, 618,100 volts for 10, 50, 90 cm. spark length, respectively. He also showed the influence of a variation of the capacity of the condenser.—*Zeit. f. Elektrochemie,* May 23.

Analyzing Periodic Waves.—FISCHER-HINNEN.—An illustrated description of a quick method of determining the single harmonics into which a periodic wave is resolved according to Fournier's theorem. To obtain one point of the *n*th harmonics, he adds the ordinates of *n* points of the main curve, distributed at equal intervals over a wave length, and divides the sum by *n*. The determination of two points is sufficient for plotting this harmonics. The fundamental wave cannot be determined by this method. For the third and fifth harmonics corrections must be applied later. The method seems to be very quick and practical. It is claimed to be much easier than that of Houston & Kennelly, as the latter method requires the determination of as many areas as lengths of ordinates must be read in Fischer-Hinnen's method.—*Elek. Zeit.,* May 9.

REFERENCE.

Anode Rays.—HIBBERT.—A brief illustrated description of several experiments with anode rays.—Lond. *Elec. Rev.,* June 7.

ELECTRO-CHEMISTRY AND BATTERIES.

"Short-Circuit Diagrams" of Storage Batteries.—M. U. SCHOOP.—An article in which he gives "short-circuit diagrams" of a lead accumulator, obtained by the following method. From a battery currents were taken for a very short time, about 2 or 3 seconds, and the voltage at the terminals, the current, and the voltage at open circuit, were measured. The currents taken out of the battery were gradually increased up to short circuit. These measurements were made for about 7 different current strengths. The whole duration of such a test was about 5 minutes. The behavior of each electrode separately was also determined by means of a third auxiliary electrode. The results of the tests were used for plotting the "short circuit diagrams," in which the current strength in amperes are the abscissas and the voltage at the terminals and e. m. f., respectively, are the ordinates. The e. m. f. and the voltage at the terminals are straight lines. The measurements were made with a battery giving normally 25 amperes in 3 hours. The "short circuit" tests were made immediately before the beginning of the normal 3-hour discharge, and immediately after the discharge. In both cases the voltage drop (difference of e. m. f. at open circuit and voltage at the terminals with closed circuit) is considerably greater at the spongy lead plate than at the peroxide plate. The e. m. f. at the spongy lead plate is nearly constant for all current strengths used by him, while the e. m. f. at the peroxide plates decreases with increasing current strength. The e. f. m. at the spongy lead plate is only slightly smaller after the normal 3-hour discharge than before. He asks what is the reason of the large voltage drop at the spongy lead plate which is considerably greater than at the peroxide plate? He does not seem to have found a satisfactory explanation. He concludes that "the exhaustion of pasted peroxide plate is mainly due to slow diffusion of acid, i. e., to developing a lack of acid in the pores of the plate, while the capacity of spongy lead plates is principally due to the physical properties and to the quantity of the spongy lead. This supposition is confirmed by the well-known fact that the voltage and e. m. f. of a spongy lead plate which is being discharged drops suddenly, while the voltage and e. m. f. of a peroxide plate which is being discharged drops gradually, and that the "recovery" is mainly due to the peroxide plates." This refers, of course, only to a battery, of which both plates have the same capacity.—*Centralblatt f. Accum. u. Elemkunde,* June 1.

Electrolytic Phenomena at the Boundary Surface of Two Solvents.—RIESENFELD.—A German electro-chemical society paper on the concentration changes at the boundary surface of two solvents, during electrolysis. He uses a U-tube, the lower part of which contains a solution of K I in phenol, while the two arms of the tube above this solution contain an aqueous solution of K I. In the interior of each electrolyte there can be no concentration changes, but at the boundary surface the concentration must change, as the transport number of the ions are not the same in both solvents. He shows that in the case of his U-tube with the two boundary surfaces, the concentration at one of them must increase, that at the other must decrease, the amounts of increase and decrease being equal and proportional to the difference of the transport numbers of the cation in phenol and water. At which of the two boundary surfaces the increase of concentration takes place, depends only on the relative velocities of migration of the ions in the two solvents. An experimental determination of the concentration change enables one to draw a conclusion concerning the relation between the migration velocities in the two solvents. He describes some experiments which he has made.—*Zeit. f. Elektrochemie,* May 23.

Production of Perchlorates by Electrolysis.—WINTELER.—A German electro-chemical society paper giving an account of experiments on the electrolytic production of perchlorates. He remarks that the perchlorates should be of industrial importance on account of the high percentage of oxygen which they contain. They are well adapted for explosive materials and for various oxidizing processes, especially those of fusing. Perchlorate of potassium contains 46 per cent, by weight, of oxygen, perchlorate of sodium 52 per cent, perchlorate of ammonium 54 per cent. The electrolytic production of perchlorates is a very simple process. He investigated the influence of concentration, current density, temperature and material of electrodes upon the electrolysis of solution of chlorides and chlorates of alcalies. He first electrolyzed a neutral solution of chloride of sodium. He found that the concentration of chlorate, as long as it is not below a minimum, has no great influence upon the output. The perchlorate which is formed and must then participate in the electrolysis, has no influence upon the final result of the electrolysis. The current density and the temperature have an enormous influence upon the output of perchlorate. The results of his tests are given in curves. The higher the current density at constant temperatures and the lower the temperature at constant-current density, the greater is the output of perchlorate. The condition of the surface of the electrodes—whether polished or rough, has also some influence. At a polished platinum electrode the oxidation process is considerably greater. He also investigated whether in the electrolysis of chlorides, perchlorates are formed in the very beginning, or only after hypochlorite and chlorate have been formed. He used various methods with and without a diaphragm, and at different temperatures, but he could not detect any primary formation of perchlorate as long as the chloride was in the solution in considerable quantities. Perchlorate was only found after the percentage of chloride had decreased below a certain minimum. This minimum was different for different solutions. It was between 5 and 0.4 per cent by weight.—*Zeit. f. Electrochemie,* May 23.

Periodic Phenomena in Electrolysis.—KOELICHEN.—A German Electro-Chemical Society paper, giving an account of experiments in which he investigated peculiar periodic phenomena, taking place during the electrolysis of sulphides of alcalies. The best oscillations are obtained with concentrated solutions of monosulphide of sodium at a current density of 10 to 20 amperes per square decimeter. When the circuit is closed the measuring ammeter and voltmeter at first tremble, after which periodic oscillations are gradually formed. He found that the seat of these periodic oscillations is the anode and that the oscillations are due to a periodic change of the resistance of the anode. This change is due to the deposition and redissolving of sulphur at the anode. Some curves thus obtained are reproduced. In the discussion which followed, other cases of periodic phenomena in electrolysis were mentioned.—*Zeit. f. Elektrochemie,* May 23.

Application of Elcetrolysis to Organic Compounds.—HEWITT.—A continuation of his serial. He first deals with alcohols. The preparation of alcohols by electrolysis is probably not feasible, neither is the conversion of alcohols into other substances by electrical means likely to be of service in many cases, although the electrolytic production of chloral from ordinary ethyl alcohol is now carried out technically. Electrolysis has been proposed for the purification of alcohol, and the question of using ozone for the ageing of wines has attracted some attention. He also deals with acids and aldehydes and ketones. One aldehyde of technical importance is produced by an electrolytic method, viz., chloral. A still is divided by a diaphragm. In the anode space is a hot concentrated solution of potassium chloride. The anode itself is of carbon, and movable, so as to act as stirrer at the same time. The cathode is of copper. Electrolysis is carried out at 100 degs. C., alcohol being allowed to flow into the anode space where, in contact with the nascent chlorine, it is converted itno chloral; 50 grams of chloral are produced per horse-power-hour.—*The Elec. Chem. and Met.,* May.

Potential Between Metals and Non-Aqueous Solutions.—KAHLENBERG.—An account of experiments in which he tested the formula of Nernst for the e. m. f. in a concentration cell with organic solvents. He found that the formula does not apply to non-aqueous solutions.—*Jour. Phys. Chem.,* Dec., 1900; abstracted in *Science Abstracts,* May.

REFERENCES.

Ketones.—Elbs.—A brief German Electro-Chemical Society paper on the electro-chemical reduction of ketones.—*Zeit. f. Elektrochemie,* May 23.

Peroxide of Hydrogen.—Bredig.—An account of an investigation of Calvert of the condition of peroxide of hydrogen in an alkaline solution by the methods of physical chemistry. He found that the peroxide of hydrogen acts as an acid.—*Zeit. f. Elektrochemie,* May 16.

Units, Measurements and Instruments.

Commercial Dry Cells as Standards of E. M. F.—St. John Hyde.—An account of "Experiments with commercial dry cells for secondary standards of e. m. f." While the standard Clark cell can be used only under special conditions because it is not constant, except with 10,000 ohms in circuit, he says that the "Mesco dry battery" and other dry cells are constant with 5 to 10 ohms. Three Mesco dry cells of an e. m. f. of about 1.4 volts were investigated. He found that "the e. m. f. is constant to 1 per cent or better, under all usual conditions, and this type of cell need only be standardized at long intervals; that time has but little effect on e. m. f. Even when polarized the cells recover their original e. m. f. almost completely."—*School of Mines Quart.,* April.

Mercury Standard for the Ohm.—Jaeger and Kahle.—In a former paper an account had been given of the construction of two mercury columns for the standard of resistance in the Reichsanstalt. It was thought advisable to use a larger number of mercury columns in the definition of the practical unit of resistance, and three others were accordingly made. In the present paper they give a detailed account of the standardizing of these three. One had a section of about 0.5 sq. m.m., and a resistance of about 2 ohms. The second, a section of 1.3 sq. m.m. and 0.5 ohms resistance, and the third, like the old ones a resistance of about 1 ohm and a section of 0.75 sq. m.m.—*Zeit. f. Instrumentenkunde,* Jan.; noticed in *Science Abstracts,* May.

REFERENCES.

Measuring Permeability.—Lamb and Walker.—A paper read before the Inst. of Elec. Eng., in which they describe an instrument for measuring the permeability of iron and steel. They endeavored to construct an instrument which would be extremely simple to use, and whose calibration should be based upon such principles as would render it incapable of alteration with time and with somewhat careless usage. The principle adopted is that of balancing the reluctance of an air-gap against that of the specimen under test by means of altering the length of the air-gap. They describe in detail the construction, use and calibration of their instrument.—Lond. *Elec.,* June 7.

Localization of High-Resistance Breaks.—Rymer-Jones.—The first part of a long illustrated description of a test for localizing a high resistance break in a submarine cable. The method is described and several tables for its use are given.—Lond. *Elec. Rev.,* June 7.

Telegraphy. Telephony and Signals.

Sine Waves and Cable Telegraphy.—Breisig.—An illustrated article on the question whether the theory of alternating currents with pure sine waves may be applied to problems of cable telegraphy. He discusses the "sine-wave transmitter" of Crehore and Squier, and investigates whether, from a purely electrical standpoint, the form of e. m. f. obtained with this transmitter is more favorable than that obtained with the battery system. He emphasizes the fact that in practical cablegrams no strictly alternating currents are sent through the line, but there are positive and negative half waves indiscriminately, so that sometimes several half waves of the same sign follow another without intermediate half waves of the opposite sign. In the theoretical considerations of Crehore and Squier it is assumed that this practical case may be treated theoretically like the ideal case that a positive half wave is always immediately followed by a negative half wave, and this again by a positive half wave, and so on. He remarks that such an assumption has yielded wrong results in the investigation of another problem, dealing with the most favorable electrical design of the transmitting and receiving apparatus. An account of the investigation of this problem is given in detail. It was, therefore, very uncertain whether the above supposition had not lead Squier and Crehore to wrong results also. He examines their system and starts from the case that a positive half wave is followed after a sufficient interval by a negative half wave. He obtains the result that when e. m. f.'s of equal maximum value are used with the sine wave transmitter system, and the battery system, the sign received with the latter system is the greater one. In the comparison of these two systems Crehore and Squier have introduced the term equivalent voltage, meaning that the amplitude at the beginning of the cable has the same maximum value. The present author believes that this definition of the equivalent is not correct, as it is based upon inexact supposition regarding the e. m. f. at the beginning of the cable with the battery system. He claims, therefore, that in Crehore and Squier's comparison of their system with the battery system, the equivalent e. m. f. has been assumed too low for the latter system, so that their results are too favorable to their own system. He claims that the Crehore and Squier system has from purely electrical standpoint, no advantages over the battery system, although the differences in the results with both systems are only slight. But it may have other advantages, for instance, such due to the great simplicity of the sine wave transmitter, compared with the complicated form of the old transmitter. He concludes that the application of the theory of pure sine waves, leads to wrong conclusions in problems of cable telegraphy in such cases in which the time required for the complete transmission of an elementary sign on the cable is large compared with the period of the sinusoidal alternating current.—*Elek. Zeit.,* May 16.

Transmission of Compass Readings.—Weber.—A paper read before the Electrotechnical Society, of Berlin, on the problem of transmitting compass readings. A compass used on an iron ship does not give correct indications. It is desirable to place the compass at the most favorable place, for instance, at the top of the mast, where it is acted upon only by the terrestrial magnetism, and to transmit its readings to places at the ship where they are wanted. Several methods have been suggested, but do not seem to have been introduced into practice. He suggests a method which enables one to obtain on board ship at any time at any number of places corresponding indications of the instantaneous course of the ship. His fundamental idea has been to generate the electric currents required for the transmission of the indications, exclusively from the terrestrial magnetism.—*Elek Zeit.,* May 9.

REFERENCES.

Buffalo.—An illustrated article on independent telephony in Buffalo and vicinity.—*West. Elec.,* June 8.

Telephone Apparatus.—An illustrated article on some new telephone apparatus and appliances of American make.—*Elec. Rev.,* June 8.

Batteries Used in Telephony.—Higgins.—The first part of an elementary article in which he describes several type of primary cells and discusses the methods of connecting them.—*El'ty,* June 12.

Telephone Line Construction.—The first well illustrated part of a serial written by "a Bell engineer." He describes in detail the method of setting and equipping poles.—*Tel. Mag.,* June.

Danger for Telephone Wires from Broken Trolley Wires.—An illustrated description of a device of Schoenberger for preventing the dangers arising for telephone or telegraph wires from a broken trolley wire.—*Elek. Zeit.,* May 30.

Repeater for Wireless Telegraphy.—Collins.—An illustrated article on the Guarini repeater system for wireless telegraphy, which was noticed before in the Digest.—*West. Elec.,* June 15.

Miscellaneous.

British National Physical Laboratory.—Some editorial notes on a discourse of Glazebrook on this new British institution which is "to supply to the industries of this country a fuller measure of scientific and technical stimulus than at present exists." It is modeled on the German Reichsanstalt. Buildings and grounds have been presented for this purpose, and plans for the alteration and equipment of this site are being rapidly carried into execution. Among the subjects suggested as affording scope for useful research, are the following: The properties of iron and steel, when raised to a few hundred degrees below the melting point and cooled in various ways. The wind pressure on bridges and large structures. The properties of glass, especially in relation to its chemical constituents, etc. As the institute is regarded so far only as an experiment, the Government grant of funds is somewhat small.—Lond. *Elec.,* May 31.

REFERENCE.

Glasgow Exhibition.—The first articles of a series on exhibits at this exhibition.—*Lightning,* May 16, 23, 30.

The first of a series of articles on "steam electric generators at the Glasgow exhibition." This article deals with Willans and Robinson sets.—*Eng'ing,* May 31.

Electrical Engineering Industry in Continental Europe.—An article giving some information on the financial conditions of the larger companies of the Continental European electrical engineering industry.—Lond. *Elec. Rev.*, June 7.

Paris Exposition.—RUHMER.—An illustrated description of induction coils and interrupters exhibited.—*Phys. Zeit.*, May 25.

New Book.

ELECTRICAL DESIGNS. Descriptions of Electrical Apparatus of Simple Construction. New York: American Electrician Company. 262 pages, 289 illustrations. Price, $2.

This book gives descriptions in detail and dimensioned drawings for direct current motors or dynamos of from 1-6 to 3 horse-power, rotary converters of from 1 kilowatt to 4 kilowatts, a 100-ampere alternating-current rectifier, a 1-hp induction motor, transformers of from 200 to 1000 watts capacity, rheostats, voltmeters, ammeters, wattmeters, galvanometers of various types, a photometer and other pieces of experimental and commercial apparatus, such as storage battery cells, arc lamps, induction coils, telephones, etc. In general, the designs are well worked out, the dimensions conform to good commercial practice and the descriptions and drawings will enable any one with ordinary mechanical skill to construct the apparatus. The degree of skill required depends, of course, upon the nature of the machine or piece of apparatus to be made. Many of the simpler pieces, such as the galvanometers, transformers and testing set, are within the ability of any one with a few hand tools. The larger dynamos and converters, on the other hand, would require the facilities of a moderate-sized shop for their construction.

The designs for the direct-current motors, the transformers and the photometer are particularly good, the latter being a most excellent instrument which can be easily and cheaply constructed, and should do good work. The rotary converters follow closely commercial practice in their general form and construction, but seem to have the output overrated, and to be somewhat weak mechanically, especially in the smaller parts. The measuring instruments can be easily made and need only careful workmanship to make them very satisfactory.

The book will be of much interest and value to those who have occasion to design, repair or use small electrical machinery, measuring instruments and apparatus of various kinds, not only on account of the designs given, but also because much information, which will be useful in any kind of construction, is scattered through its pages.

BOOKS RECEIVED.

EXPERIMENTAL PHYSICS. By Eugene Lommel. Philadelphia: J. B. Lippincott Company. 664 pages, 430 illustrations. Price, $3.75.

RECORDING AND INTEGRATING ELECTRIC METERS. How to Inspect, Repair, Test, Calibrate, Read and Compute. By Robert Ferris. Monmouth, Ill.: Robert Ferris. 47 pages, illustrated. Price, $1.

PRACTICAL ELECTRO-CHEMISTRY. By Bertram Blount. New York: Macmillan Company. 374 pages, 46 illustrations. Price, $3.25.

Directory of Electrical Societies, Etc.

AMERICAN STREET RAILWAY ASSOCIATION. Next meeting, New York, Oct. 9, 10 and 11, 1901.

ASSOCIATION OF THE EDISON ILLUMINATING COMPANIES. Next meeting, Sept. 10, 1901.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Next meeting, Niagara Falls, N. Y., September, 1901.

NEW YORK STATE STREET RAILWAY ASSOCIATION. Next meeting Rochester, N. Y., September, 1901.

OHIO ELECTRIC LIGHT ASSOCIATION. Next meeting, Put-in-Bay, Ohio, Aug. 20, 21 and 22.

OLD TIME TELEGRAPHERS' ASSOCIATION AND UNITED STATES MILITARY TELEGRAPH CORPS. Next meeting, Montreal, Que., Sept. 11, 12 and 13, 1901.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION. Next meeting, York, Pa., Sept. 4, 1901.

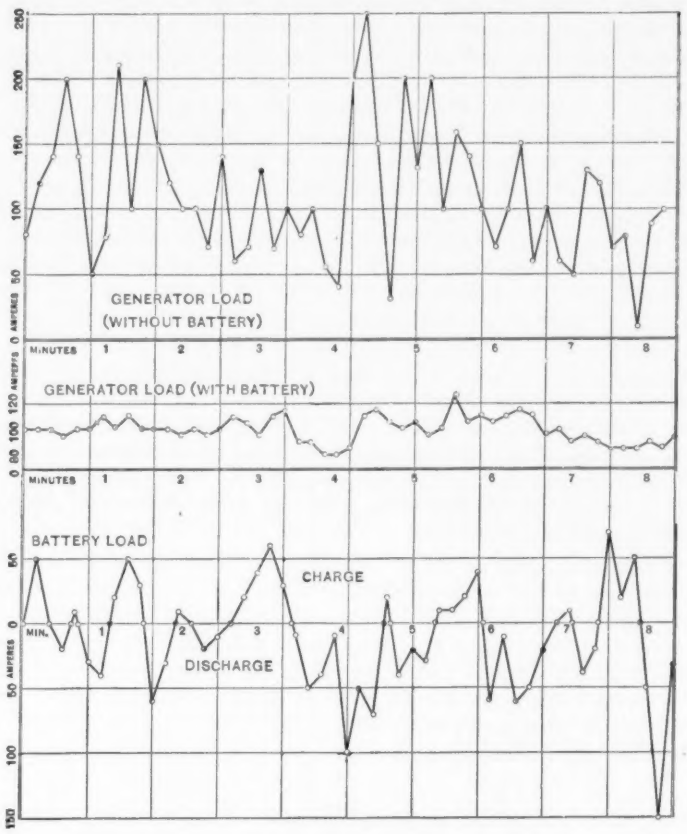
Storage Battery Plant of Lansing, Mich., Street Railway.

BY THOMAS J. FAY.

THE Lansing Street Railway Company, of Lansing, Mich., finding that the service was not improving as the load factor increased with the growing demand, finally took up for consideration the addition of more generating capacity and more copper for the transmission system, or the installation of a storage battery.

That a storage battery is the equivalent of additional dynamo capacity and additional copper in the transmission system goes without saying, and the results obtained at Lansing appear to offer proof positive of the hypothesis. A dynamo, if run at full load continuously, will deliver its full rated output in ampere-hours, but if the translating devices do not require the full output continuously, the impracticability of taking advantage of the generator capacity is a self-evident proposition unless a reservoir is provided for the surplus. A storage battery is such a reservoir.

In the next place, if the copper in the transmission system is scant, the "drop" in transmission resulting from heavy demands by trans-



LOAD CURVES OF A STREET RAILWAY POWER STATION.

lating devices at a distant point from the source, will be excessive, and in the event of street cars being the translators, the attainable speed will be diminished and the motors will be subjected to extra and hazardous strains; for at a low voltage the current in amperes will be correspondingly high, and hence the C^2R losses will be augmented.

The storage battery at a distant point from the source of power does two things, namely, it reduces the distance of the transmission and acts as an independent source of e. m. f.

The storage battery problem is exceedingly simple in railway work because, owing to the allowable loss in transmission, the battery may be "floated" across the system in parallel with the generators, without the use of any regulating device as booster-crushers or end-cell switches.

At Lansing the battery is connected permanently across the line with absolutely no regulating equipment at all, and the results attained are so good that the plant is stated now to be run with a reduction of 50 per cent in the capacity of the generating plant. Prior to the introduction of the Gould battery the plant was struggling along with two units of 80 kilowatts each, and with the maximum load exceeding 160 kilowatts, with the result that the engines were being hammered out of existence, and the generators running

overheated. After the battery was installed, one 80-kw generator was found to be capable of handling the load with no danger of being burned out.

The power required to operate the plant does not exceed 80 × 24 or 1920 kilowatt-hours per day, but the "freak" loads exceed 160 kilowatts many times during the day's run. The arrangement is such, using the battery, that when the demand is less than 80 kilowatts the battery furnishes the difference.

The exact performance is best shown by the load curves of Fig. 1. The conditions are represented in this diagram in such a plain manner that comment is unnecessary. That the operating expenses will be materially diminished in this plant is now an established fact, the plant having been run with and without a battery long enough to establish the fact.

The battery is one of the type capable of withstanding discharges down to the full output in a quarter of an hour. The output of this battery ranges from 320 ampere-hours for eight hours to 96 amperes for one-quarter hour, at the 8-hour rate, being 40 amperes, and at the quarter-hour rate, 384 amperes.

The battery is capable of furnishing the maximum required current for the most savage "freak" demand with a margin to spare, and as a result the generator is not subjected to fluctuations at all.

Referring to the question of efficiency, the steam plant works at its most efficient point, the generator is equally well placed, and the battery is capable of delivering nearly 100 per cent of the ampere-hour influx and about 87 per cent of the wattage influx at the 8-hour rate. As to the effect of high rates of discharge on the efficiency, it is sufficient to say that the time element is short, and if the energy is not taken out it is still available; that is to say, if 96 ampere-hours are withdrawn at a 384-ampere rate, then by putting back but little more than 96 ampere-hours, 320 ampere-hours can be taken out at the 40-ampere rate, and so on.

This can only be done to a high degree with an electro-chemically formed battery out of pure rolled lead plates in which the surface is increased by a suitable spinning or grooving process to such a point that the active material forms a thin, porous, cohesive and integral part of the conducting grid. This condition, however, cannot be attained in types of battery of which a large percentage of the active material is entirely inaccessible, and an even larger proportion so inaccessible that the diffusion of acid only takes place at a low and sluggish rate.

The performance of the Gould battery at Lansing shows another very important advance in storage battery performance, in that the battery does not demand a great change in e. m. f. to effect an economical charge, nor does the e. m. f. fall away under discharge nearly so much as has been noted in storage battery work in general. This is just what ought to be expected in a battery that is possessed of great porosity, and a thin layer of active material in intimate contact with the conducting grid.

The question of battery depreciation is not a question to receive more than passing notice in a battery in which the active material is thoroughly accessible and formed by a process that leaves it open to acid diffusion yet so evenly dispersed and in absolute contact with the supporting grid. Experience dictates that this is true, and even without experience it stands to reason that this is true.

The Plante process, as exploited by the Gould Storage Battery Company, while very old and once thought to be impracticable because of the slow formation, was considered by many as producing the most substantial type of battery, but the Gould Company so perfected its process that the cost of forming the layer constituted no obstacle to the commercial exploitation of the type.

Devices for Handling Extreme Potentials.

Switchboards and appliances adapted to the safe and convenient manipulation of the high potentials now used for long-distance transmission work have not in general kept pace with the development of the apparatus and appliances for the production of these high potentials. The apparatus illustrated herewith for this work, though new to the trade, has been thoroughly tried and proved successful.

To handle safely potentials from 5000 to 60,000 volts requires apparatus designed and constructed with special care. Probably the most important piece of apparatus for high-voltage work is a thoroughly reliable switch for connecting high-potential transformers and generators to lines at the generating end of a transmitting system, and for connecting high-potential lines to step-down transformers at the receiving end.

The S. K. C. combination switch and fuse is built for pressures of 10,000 volts and higher, and of 100 amperes capacity. They are in use on the 60,000-volt circuits of the Standard Electric Company, of California, and the Bay Counties Power Company, of California.

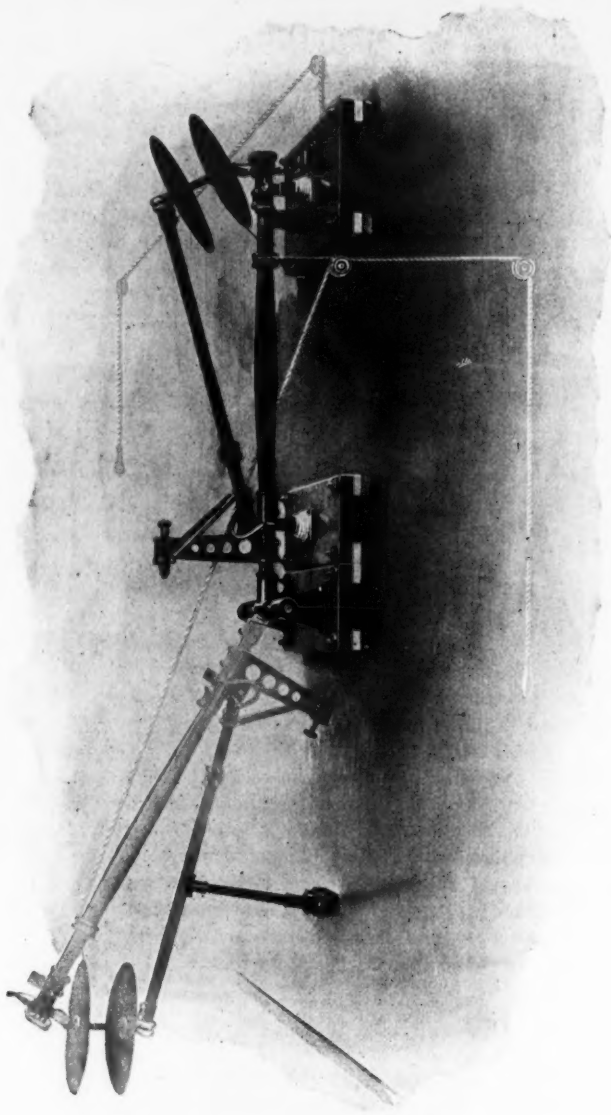


FIG. 1.—TWO POSITIONS OF SWITCH.

This type of switch depends for its successful operation on the drawing of a metal fuse through a non-conducting powder which is enclosed in an insulated tube. The arc formed due to the breaking of contacts is ruptured as the fuse passes quickly through the powder. Figs. 1 and 2 illustrate the three positions of a single-throw switch. The combination consists of the main arm, an auxiliary arm, a fuse and fuse holder, and the two terminal jaws, together with the mechanical details for the proper operation of the switch.

The main arm is a wooden rod, hinged at the bottom, and having mounted on the top two zinc jaws which clamp one end of the fuse. On this main arm are also mounted two blades which make the contact with the terminal jaws. The upper blade is electrically connected to the zinc jaws, while the lower blade is connected to the auxiliary arm by means of a cable.

As the circuit is never meant to be broken between the terminal jaw and blade, but by allowing the fuse to slip from the zinc jaws the main arm is locked in its upright position and cannot be unlocked until the auxiliary arm has dropped into the horizontal position of Fig. 2, thus breaking the circuit.

The auxiliary arm consists of a hollow wooden rod hinged to the main arm at the bottom and having mounted on the top two zinc plates, which form the holding device for the other end of the fuse. Inside the wooden arm is a copper rod forming the connection between these plates and the cable connecting with the lower blade on the main arm. This auxiliary arm is intended to be pulled

sharply away by the spring in the event of the unlatching of the fuse or the fuse blowing. The jar of its falling is taken up by the dash-pot on the bracket attached to the main arm. The switch is set sufficiently high not to come within striking distance of the attendant's head.

The fuse holder consists of a hollow insulating tube having perforated corks and large washers at each end, and containing the non-conducting, non-fusible powder through which the fuse is drawn. It is tied to the main arm to prevent its falling to the floor when no longer supported by the fuse. The fuse enclosed in the fuse holder is held in position between the main and the auxiliary arms by means of the zinc jaws on the top end of the main arm and the zinc plates on the auxiliary arm.

The jaws forming the terminals are mounted on separate pieces of marble and are thoroughly insulated by means of porcelains and bushings so as to avoid any leakage to the marble. On the upper terminal marble is also mounted the catch, operated by a rope, and which opens the zinc jaws on the main arm, releasing the fuse.

Observing the switch in its normal position, the current enters at the upper terminal, passes to the zinc jaws on the main arm, then

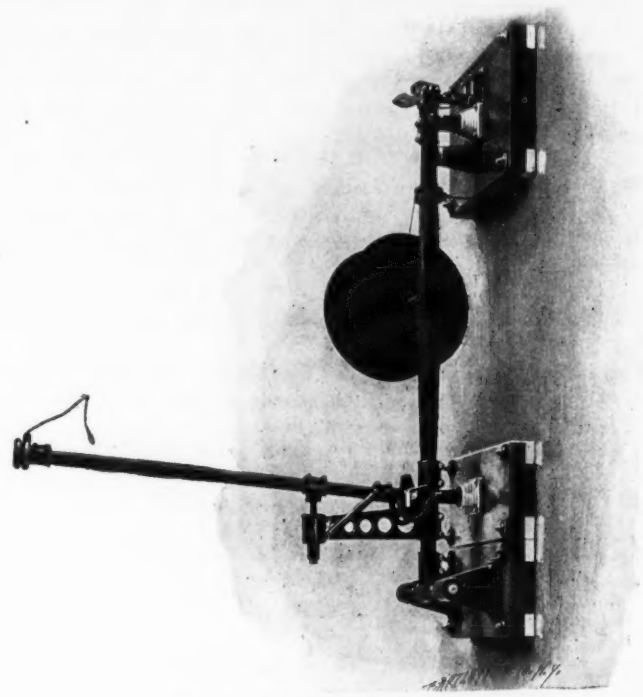


FIG. 2.—HORIZONTAL POSITION.

through the fuse to the auxiliary arm, down the auxiliary arm and through the cable to the lower blade on the main arm and thence through the lower terminal out. Pulling the rope attached to the catch opens the jaws and releases one end of the fuse. The fuse, thereupon, is passed rapidly through the non-conducting powder in the fuse holder by the auxiliary arm falling into a horizontal position, breaking the circuit and rupturing the arc.

The main arm may now be unlocked from the catch, and the whole combination allowed to swing down into position where easy access can be had to the working parts, and thus the fuse reset. This position is shown by the skeleton section of Fig. 1. After the fuse has been reset the whole combination is brought into its normal position by a rope attached to the main arm. As the combination is primarily a switch and not a fuse, the fuse is made sufficiently heavy so as to avoid its blowing under anything but extreme conditions. If on any account the fuse should blow, the action is precisely similar, except that the breaking takes place in the center of the tube instead of at the jaws.

Notes of the Railway Telegraph Superintendents' Convention.

In addition to the report of the convention which appears elsewhere in this issue, the following notes will be found of interest:

LADIES' RECEPTION.—A luncheon was served to the ladies by the Buffalo Telephone Company on Wednesday at its main exchange.

THE KNICKERBOCKER TELEPHONE & TELEGRAPH COMPANY, of New York, was represented by Mr. W. S. Eckert, its electrical engineer and general manager.

THE INDEPENDENT TELEPHONE ASSOCIATION was represented by Mr. W. S. Eckert, of the Knickerbocker Telephone & Telegraph Company, of New York.

THE SAFETY INSULATED WIRE AND CABLE COMPANY, of New York, was represented by Mr. A. P. Eckert, who gave to the members a serviceable memorandum book as a souvenir.

THE WEBB C. BALL COMPANY, manufacturer of watches, particularly recommended for railway men, was represented by W. J. Hurley, who distributed a unique money purse, which had a secret locking device.

THE RAILROAD SUPPLY COMPANY, of Chicago, was represented by Mr. E. W. Vogel, its signal engineer. The signal and electrical department of this company handles all kinds of electrical signals for railways. The company has recently acquired control of several other crossing signal companies. Mr. Vogel presented each member with a handsomely bound volume of railroad stories.

MR. HENRY W. POPE spared no pains to provide enjoyment for the members and their families and friends, and while he received the formal thanks of the association for his careful attention to this feature of the meeting, the members individually did not fail to express their appreciation for his liberal hospitality and the many courtesies extended by him and secured through his efforts.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, of Chicago, was well represented by Mr. Paul W. Bossart, who distributed among the members a leather card case. The company's excellent exhibit at the Pan-American Exposition attracted a great deal of attention, especially among those interested in railway telephone service, and of these it is a notable fact there is a constantly increasing number.

NIAGARA FALLS TRIP.—On Thursday afternoon the members and their friends enjoyed a trip to Niagara Falls on special cars provided by the Buffalo Bell Telephone Company, represented by Mr. Pope. Some of the party took a ride over the Gorge road on a special car, while the others spent their time visiting the many places of interest around the Falls. The party returned to Buffalo in the evening.

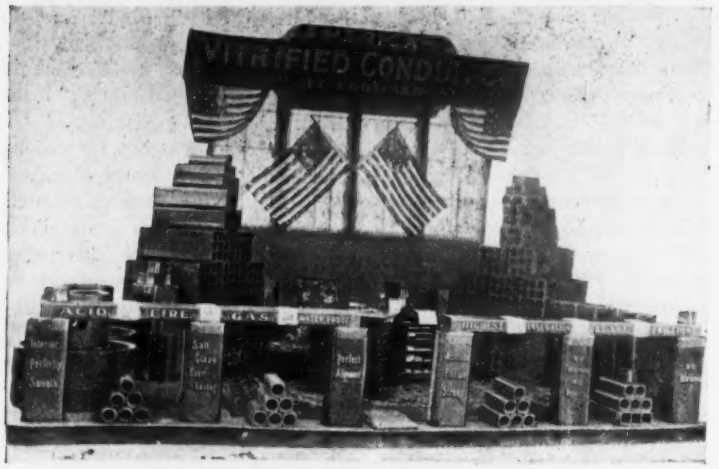
THE BUNNELL TELEGRAPHIC & ELECTRICAL COMPANY, of New York, had an exhibit of relays, sounders, keys, a fire alarm box, a police, doctor, messenger and carriage call, and a watch and fire service instrument. The company was represented very ably by Mr. H. S. Young, Jr., who presented the members with a very beautiful sterling silver matchbox, which was highly appreciated by those fortunate enough to secure one. Mr. Young did some active work in behalf of his company.

J. H. BUNNELL & CO., New York, had an able and effective representation in Messrs. W. E. McLaughlin and J. J. Ghegan. These gentlemen had an exhibit of a Morse-Phillips transmitter in practical operation in the meeting room, also an extension, loud-ringing telephone bell for use in noisy places. This instrument is practically a modification of the ordinary bell, of more powerful construction, and has two large gongs which can be readily heard above loud noises. It is operated by the ordinary calling currents. Mr. Ghegan presented the members with a souvenir in the shape of a silicate memorandum, and Mr. McLaughlin remembered the ladies by presenting them with beautiful souvenir silk handkerchiefs on which were wowen pictures of the different Exposition buildings.

Vitrified Conduit at the Pan-American.

The American Vitrified Conduit Company is prominently located in the northeast corner of the Electricity Building, with an interesting exhibit of a full line of their products showing the largest number in style and types of vitrified conduits. Its leading article of manufacture is the multiple duct conduit. While multiple conduits from 2 to 6 ducts have been for a long time well known on the market, this company is believed to be the first to succeed in producing perfectly formed 9, 12 and 16-duct conduits, which in themselves comprise complete systems. In the use of these, economical, solid and rapid construction is accomplished. Engineers have realized, it is said, that with the use of the square duct conduit cables are installed very rapidly, economically and satisfactorily, as cables are drawn into square ducts upon a flat surface; there is the least amount of friction to contend with and no possibility of shortening the life of the cables. The multiple conduits require no cement be-

tween conduits, very little concrete and none whatever on the sides. This company furnished last year all of the conduit for the Subway Commission, of Baltimore, Md., which amounted to over 5,000,000 ft. It also furnished upwards of 3,000,000 ft. to the Narragansett Electric Light Company, Providence, R. I.; the Boston Elevated Railway Company, Boston, Mass.; the Massachusetts Telephone Com-



VITRIFIED CONDUIT EXHIBIT.

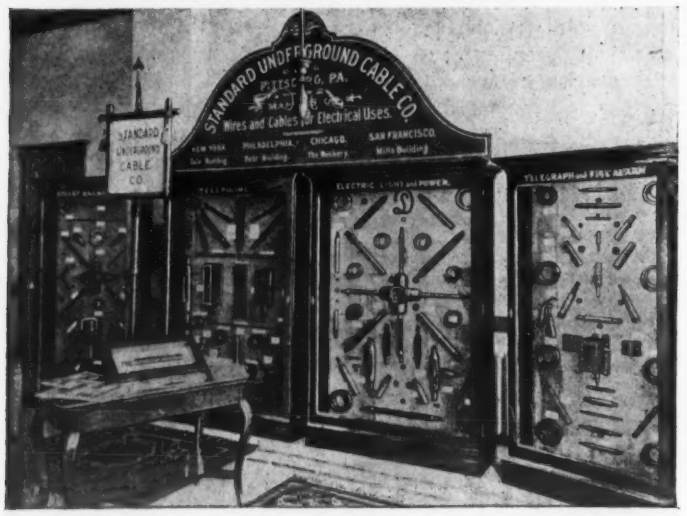
pany, Boston, Mass.; Worcester Electric Light Company, Worcester, Mass., and many other large users. For the present season the rapid transit tunnel in New York which requires 20,000,000 ft.; the Manhattan Elevated Railway Company, New York, over 2,000,000 ft., and the Metropolitan Street Railway Company, New York; the Keystone Telephone Company, and the Girard Estate, of Philadelphia, have also purchased their conduits from this company.

The American Vitrified Conduit Company's factory has an enormous capacity, and for some time has been in operation night and day. The company also has a plant in Ohio, from which the Western trade is supplied. In addition to multiple conduit the company makes a full line of single-duct conduit, of which there is a heavy self-centering type, a light self-centering in 18-inch lengths, and the common single ducts with butt ends also 18-inch lengths. These are now being turned out at the rate of 80,000-duct ft. per work-day of 10 hours.

Mr. Wardell E. Brown, who looks after the construction interests of this company, and who arranged the exhibit, and is also in charge.

Standard Underground Cable at the Pan-American.

A neat and interesting exhibit is made in Section F, of Electricity Building, of the Pan-American Exposition, by the Standard Underground Cable Company, as shown in the accompanying cut.



STANDARD UNDERGROUND EXHIBIT.

The sample boards exhibited are handsome cabinets of black walnut, backed with birdseye maple, and the cases, four in number, contain samples in one case of street railway wires and cables and accessories; another of telephone wires and cables and accessories, another of electric light and power wires and cables, and another of telegraph and fire alarm wires and cables and accessories. The samples include rubber insulated wires, weatherproof and W. A. C. fireproof wires, Marsh duplex telephone wires, and many samples of rubber insulated telephone wires and cables, as well as samples of fiber and paper insulated cables, including 200 and 300 pairs paper insulated telephone cables.

Among the accessories are terminal heads, cable hangers, lightning arresters, suspension wires, manhole brackets, etc.

Meeting of Master Mechanics' Association.

The annual convention of the American Railroad Master Mechanics' Association was held in Saratoga, June 19, 20 and 21, with a very large attendance. The papers read and the discussions which followed were extremely interesting. On June 18 the railway supply men held their annual meeting at the Grand Union Hotel, Saratoga, and appointed their various committees, who have charge of the finance, entertainment, etc., of the Master Mechanics' Convention. Among the supply men attending the convention were a number of gentlemen well known in the street railroad field, and among the exhibits the following may be mentioned as being of interest to our readers:

National Tube Works Company, of McKeesport, Pa., was represented by Mr. Nicholson.

Charles H. Besly & Co., of Chicago, represented by Edward P. Welles, exhibited taps, parallel clamps, Gardner grinders, etc.

Crane Company, of Chicago, represented by Frank D. Fenn and E. A. Kimberg, exhibited a number of its valves and other steam specialties.

Link Belt Machinery Company, Chicago, represented by J. A. Werner, had a large album of drawings illustrating the application of its machinery.

Crosby Steam Gage & Valve Company, Boston, represented by W. F. Johnson and Thomas R. Freeman, had an interesting exhibit of gauges, pop safety and other valves.

Lunkenheimer Company, Cincinnati, represented by Messrs. Samuel Mayer, C. Houghton, John Desmond and F. P. Leach, exhibited its injectors, globe valves, swing check valves, etc.

Consolidated Car Heating Company, of Albany, New York, showed its electric-heating as well as its steam-heating apparatus. It was represented by Messrs. R. P. Scales, F. C. Green and others.

Carborundum Company, Niagara Falls, N. Y., represented by F. H. Manley and R. L. Collingwood, exhibited a full line of Carborundum goods, showing its product made up in every conceivable form.

H. W. Johns Manufacturing Company, New York, represented by J. E. Meek and E. G. Sparks, exhibited a full assortment of asbestos goods, vulcabeston, lagging, packing, valves, air brakes, packing rings, etc.

Keasbey & Mattison Company, Ambler, Pa., also exhibited lagging and asbestos material, including valve and piston packings, and were represented by Messrs. George R. Wallace, R. L. Thomas, W. S. Gilmore and W. I. Harwood.

Standard Paint Company, New York, represented by J. C. Shainwald, Charles Earnshaw and J. N. Richards, had a car model with a rubberoid roof. The model illustrated the insulation of a refrigerator car and was painted with the famous P. & B. preservative paint.

Chicago Pneumatic Tool Company, Chicago, represented by W. O. Duntley and Messrs. Joseph and Frank Boyer and Thomas Aldcorn and others, exhibited the pneumatic tools made by this company, and also the Duntley electric headlight and motor. The company distributed a gold pencil as a souvenir of the convention.

Jenkins Brothers, New York, represented by Messrs. Joseph H. Williams, A. C. Langston, Charles W. Martin, Jr., and H. D. Gordon, had an interesting exhibit of packing and magnetic lamp holders for incandescent lamps, and also naturally their well-known line of valves and their rubber goods, such as Union rings, washers, gasket tubing, etc.

Bullock Electric Manufacturing Company, Cincinnati, was represented by Mr. Frank G. Bolles, who looked after the customers of the Bullock Electric Manufacturing Company very assiduously. Mr. Bolles states that the Bullock Company do a large business among the steam railroads, and many of the master mechanics pres-

ent spoke highly of the Bullock motors which were in use in their various shops.

MANNING, MAXWELL & MOORE, New York, represented by Messrs. Charles A. Moore, John D. Derby, A. J. Babcock and P. M. Brotherhood and others, exhibited a full line of the Ashcroft gauges, Consolidated valves, Metropolitan injectors, H.-D. ejectors, Hancock inspirators, steam valves, check valves, hose couplings, etc. One of the interesting features of its exhibit was the first Hancock inspirator made a quarter of a century ago, still standard in design.

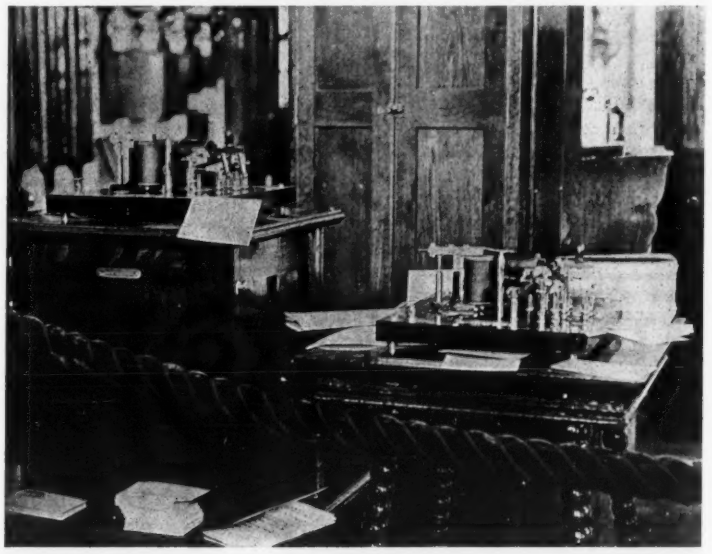
GENERAL ELECTRIC COMPANY, Schenectady, N. Y., was represented by Messrs. E. H. Mullin, Charles Pierce, Hawkes and J. L. Roe. It exhibited a 7-hp variable speed motor direct connected to a boring mill. The motor was driven by two G. E. generators belted to a G. E. motor, which in its turn was driven by power taken from the street railway circuit. The exhibit illustrated the method of operating machine tools by a direct-connected variable speed motor.

GOLD CAR HEATING COMPANY, of New York, represented by Edward E. Gold, John E. Ward, William E. Banks and James Watson, exhibited its electric car heater, electric heat regulating switch for street railway work and its locomotive equipment for steam heating and its car heating system for the different classes of cars. This company gave away the most handsome souvenir seen at the convention, a gold pencil, which was eagerly sought for, and which will serve to keep the name of "Gold" in the minds of every recipient.

RAILWAY LIGHTING.—An interesting exhibit was made by the Consolidated Railway Electric Lighting & Equipment Company, of New York, which was represented by John N. Abbott, J. L. Watson, Colonel John T. Dickinson, P. Kennedy and Arthur J. Farnsworth. It had a car belonging to the A. T. & S. F. Railway Company entirely equipped with its lighting system, with 15 lamps in the buffet and 24 lamps in the mail portion of the car. The car was stationed near the depot on the D. & H. tracks, and it was visited by practically all the railroad men present at the convention, who manifested great interest in it. It seems to be the universal opinion of those who saw the car that the system was one which has come to stay.

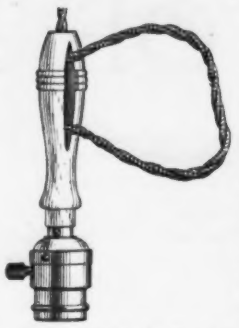
The Warner Ringer at the Pan-American.

Among the interesting telephone exhibits in the Electricity Building at the Pan-American Exposition is that of the Warner Electric Company, of Muncie, Ind., which makes the Warner pole changing device for central office ringing. This is exhibited in the booth of the American Electric Telephone Company. These ringers consist of a small vibrating pole changer which is kept constantly vibrating by one cell of Edison-Lalande battery. The pole changer serves to change from direct to alternating the current from 40 to 60 cells of dry battery, which current is used for central office ringing. One of these pole changers mounted on the cabinet which contains the dry batteries is shown at the left in the accompanying view of the exhibit. In case dry batteries are not used, wet batteries can be put in a storeroom and only the pole changer, shown at the right, is necessary.



TELEPHONE RINGER.

New Cord Adjuster.



A new cord adjuster for incandescent lamps, herewith illustrated, has just been put on the market by Mr. George Webster, of Christiana, Pa. It is stated that this form saves half a cent's worth of cord, as compared with the cord in the ball form of adjuster, as the handle permits the utilization of all the cord in it, and requires no extra cord for its operation. It also holds the cord more tightly than is customary. The handle is at once strong and neat.

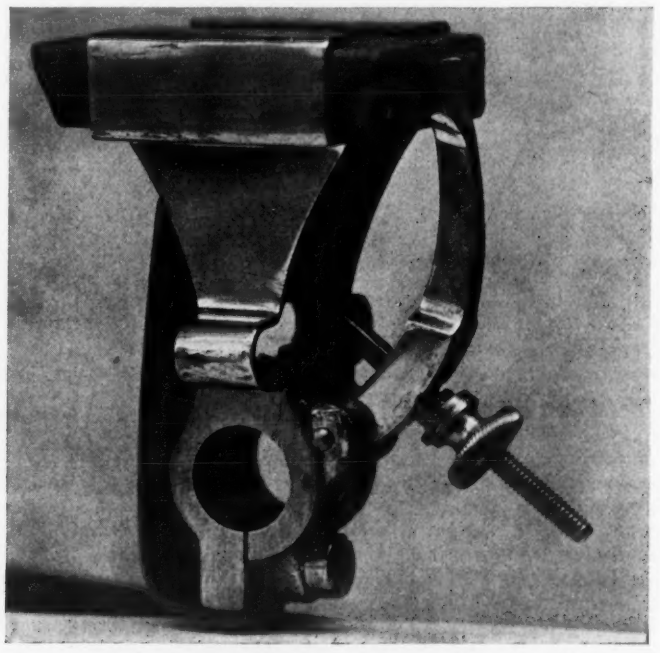
The device is so simple that an explanation of its operation would be superfluous.

Socket Carbon Brush Holder.

An improved form of socket carbon brush holder has recently been patented by Mr. Oscar M. Stiegler, of Jamaica Plain, Mass. It is herewith illustrated. This brush holder is a brass casting which clamps onto the brush-stud, with two parts of sheet copper bent into shape so as to form the socket for the carbon brush when screwed into the recess of the head. The carbon brush is pressed against the commutator by means of a pressure-arm connected to a phosphor bronze spring, which is screwed to the extreme end of the head, making it long and flexible.

One novel feature is a T-shaped sheet-metal punching, with a square hole in the centre, used as a washer for the tension-nut while the two points rest in a groove in the pressure-arm, and act as a fulcrum. The tension-screw, being of square brass rod, makes it impossible for the washer to turn, and thus the points will always find their way into the groove.

One of the principal features of this holder is that the carbon brush is free from any separate connection for the purpose of contact, and can be removed from the socket for the purpose of cleaning, without moving the holder from its position. The contact between the brush and the holder is made perfect by the constant gentle pressure of the sheet-copper upon the sides of the carbon brush. Another good point is that it can be adjusted to take any brush, varying in width to one-fourth of an inch. This is a desideratum, if the brush desired should be but one-sixteenth inch wider than the commutator surface. As there is nothing to obstruct the brush from going through the socket, more than two-thirds of the brush can be used.



CARBON BRUSH HOLDER.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Call money closed nominally at 3 per cent. Time money was firmer, the rates being 3½ per cent for 60 to 90 days. Mercantile paper is quoted at 3¾@4¼ per cent for endorsed bills receivable; 4@4½ for highest grade, four to six months, single names, and 5@5½ for others. In the stock market speculation was quieter, and some reactionary tendencies were shown in prices, owing to fears of firmer money prior to July 1. Traction stocks were somewhat irregular, and a pool seemed to be working in Brooklyn Rapid Transit, basing its operations on an improvement in the earnings. This latter stock closed with a net gain of 1 point, the sales aggregating 126,200 shares. Metropolitan Street Railway was quiet, with a weakening tendency. The sales amounted to 24,600 shares, and the closing price was 1 point below that of the week previous. General Electric was held very firmly and the price continues to soar higher and higher. On Thursday it jumped to 263 from 248, the closing price on Wednesday, and practically maintained this high water mark up to the close, the last quotation being 260, a net gain of 12 points. Western Union was fairly active as far as trading was concerned, but the price is weaker, being ½ point lower than that at the close of the previous week. United States Steel stocks continued to maintain the leading position in the industrial list, the quotations for common and preferred shares being 48½ and 98⅝ respectively at the close. The curb market during the week was generally strong. Buying was active and, in several cases, there were advances. New York Elec. Veh. Transp. was quiet until Friday, when it jumped to 14⅝, which was a gain of more than 2 points over the close of the week previous. Following are the closing quotations at New York, Boston, Philadelphia and Chicago:

NEW YORK.

	June 15.	June 22.		June 15.	June 22.
General Electric	248	260	Electric Vehicle	10	8
Brooklyn Rapid Transit	81½	82½	Electric Vehicle, pfd	16	16
Metropolitan Street Ry.	175½	174½	General Carriage	1⅞	1⅞
American Tel. & Cable	99½	100	Illinois Elec. Veh. Tran.	⅞	⅝
Western Union Tel.	96	94¼	Hudson River Tel.	120	120
American Dist. Tel.	—	—	N. E. Elec. Veh. Tran.	3⅛	3
Commercial Cable	—	—	N. Y. Elec. Veh. Tran.	11¾	14
Electric Boat	22	22	Tel. & Tel. Co. of Am.	5	5
Electric Boat, pfd.	50	50	N. Y. & N. J. Tel.	170	173
Electric Lead Reduc'n	3½	3			

BOSTON.

	June 15.	June 22.		June 15.	June 22.
New England Telephone	143	—	Erie Telephone	54	55½
Mexican Telephone	—	2¼	General Electric, pfd	—	—
Westinghouse Electric	69	—	Am. Tel. & Tel.	152	160½
Westinghouse Elec., pfd.	76	78	Boston Electric Light	—	—

PHILADELPHIA.

	June 15.	June 22.		June 15.	June 22.
Electric Storage Battery	53	67	Philadelphia Electric	5½	5½
Elec. Storage Batt'y, pfd.	52	68	Pa. Electric Vehicle	1	1
Elec. Co. of America	8¾	8	Pa. Elec. Veh., pfd.	1	1
General Electric Auto	—	—	Am. Railways	43½	41½

CHICAGO.

	June 15.	June 22.		June 15.	June 22.
Chicago Edison	177	177	Chicago Telep. Co.	275	275
Chicago City Ry.	—	206½	Union Traction	19¼	19½
National Carbon	16	18	Union Traction, pfd.	58	58
National Carbon, pfd.	84	87	Northwest Elev. com.	49	47

*Asked.

DIVIDENDS.—The directors of the Cincinnati Gas & Electric Company have declared the regular quarterly dividend of 1 per cent, payable July 1. Directors of the American Telephone & Telegraph Company have declared a regular quarterly dividend of 1¼ per cent and ¾ per cent extra. New York, Metropolitan Street Railway has declared the regular quarterly dividend of 1¾ per cent, payable July 15. The Boston Electric Light Company has declared the regular quarterly dividend of $2 per share and an extra dividend of $1, payable August 1. The directors of the Westinghouse Electric & Manufacturing Company have declared the regular quarterly dividend of 1¾ per cent on the preferred stock, payable July 1. The directors of the Washington Water Power Company, of Spokane, Wash., have declared a quarterly dividend of 1 per cent, payable July 1. The Electric Storage Battery Company has declared the usual dividends of 1¼ per cent for the quarter ending June 30 on both common and preferred stock, payable July 1. The directors of the Columbus Edison Company have declared a dividend of 3 per cent on the preferred stock, payable June 29. The directors of the Mexican Telegraph Company have declared the regular quarterly dividend of 2½ per cent, payable July 1. The directors of the Central & South American Telegraph Company have declared the regular quarterly dividend of 1½ per cent, payable July 9.

DALLAS CONSOLIDATED ELECTRIC.—The sale of the Dallas (Tex.) Consolidated Electric Street Railway was consummated on June 11. The names of the purchasers are not known, but it is supposed that they are Pierre S. Dupont, of Lorain, Ohio, and his associates, who were negotiating for the purchase of the property. The system is a consolidation of the Dallas City Street Railway Company and the Queen City Railway Company, both of which were sold under foreclosure of mortgage. The Dallas Consolidated Street Railway Company was chartered in January, 1898, for fifty years, and is capitalized at $1,000,000. The company has outstanding first mortgage bonds to the extent of $365,000, which cover the entire property, and second mortgage bonds to the amount of $25,000, which cover the property formerly owned by the Queen City Railway Company.

NEW ENGLAND TELEPHONE.—At a meeting of the directors of the New England Telephone & Telegraph Company it was voted to issue $2,577,000 new stock. Payments are to be made one-half August 16 and one-half November 16. This issue will give rights to one share of new stock at par for every six shares now held. Part of the new issue will pay for the construction already done during the first half of this year, and will provide for the needs of the company for the remainder of 1901, and a portion of next year. The New England Telephone Company now has about 80,000 subscribers and is adding to this number at the rate of about 1,000 new subscribers per month.

NASHVILLE TROLLEY'S DEFAULT.—A receiver was appointed on June 22 for the Nashville Street Railway, capitalized at $13,000,000. Application was made in the United States District Court by the Baltimore Trust and Guarantee Company, which, as holders of $2,060,000 of the company's bonds, alleged that interest payment was defaulted last February. The complainants prayed for foreclosure, and on their petition Judge Clark appointed E. F. C. Lewis and Percy Warner receivers, pending a sale by foreclosure. Joint bond of $30,000 was given by the receivers, who at once assumed control of the property. The company's capitalization is half in bonds and half in stock.

BOSTON CONSOLIDATED.—Stockholders of the Edison Electric Illuminating Company of Boston at a special meeting last week, voted unanimously to purchase the Boston Electric Light Company's property. The total vote cast was 30,891 shares out of 43,105 shares outstanding. Stockholders of the Boston Electric Light Company also voted to accept the offer of the Edison Electric Illuminating Company of Boston for the purchase of the Boston Electric Light property by an exchange of shares. Of 30,000 shares outstanding, 21,033 voted in the affirmative. It was also voted to increase the board of directors from 9 to 12 members in order to give representation to Boston Electric Light interests.

AMERICAN LIGHT & TRACTION.—It is officially announced that July 1 has been fixed as the date on which dividends will begin to accrue on the preferred stock of the American Light & Traction Company, recently organized under the laws of New Jersey. The Trust Company of America is now prepared to deliver temporary certificates of the company's stock. The company has acquired practically all the stock of the following companies: Western Gas Company, Grand Rapids Gas Light Company, Madison Gas & Electric Company and St. Joseph Gas Company.

AMERICAN TELEPHONE & TELEGRAPH BONDS AND STOCKS.—Application has been made to list the American Telephone & Telegraph $15,000,000 4 per cent collateral trust bonds of 1929; and $114,946,000 capital stock on the New York Stock Exchange.

Commercial Intelligence.

THE WEEK IN TRADE.—During the past week the reports received by the mercantile agencies indicate that in some lines strength has been maintained, while in others further improvement is noted. The most significant feature of the trade situation is the advance in price in a number of leading commodities, notably cotton goods, bleached goods and a number of kindred products, and the increase in the price of the raw material is due as much to the better trade advices at home and abroad as to crop damage reports from the South. Iron and steel lose nothing in strength as the turn of the year approaches. On the whole, the demand for finished material is quiet, but mill production shows a seasonable shrinkage, and manufacturers are still 6 to 8 weeks behind in their orders. The railroad situation continues very satisfactory. Gross

and net returns for April from 130 railways show a gain in gross receipts of $98,274,723, and in net of $29,412,414, being 13 and 18 per cent respectively. The heaviest gains are shown by the Southwestern roads, 25.2 and 39.6 per cent respectively for gross and net. Other large gains are those made by the Central-Western and Pacific roads, 28.7 and 23 per cent respectively. The trunk lines show a gain of 14 per cent, the coal roads 11.8 per cent, and the Southern and granger lines 8.3 and 6.5 per cent respectively. In the copper market trading was quiet but firm. While the consumption is very large there does not appear to be much buying at the moment. On the other hand, reports seem to indicate that manufacturers are not well covered ahead. Quotations remain unchanged at 16⅞@17c. for Lake; 16.35@16.45c. for electrolytic in cakes, wire bars and ingots; 16.10@16.20c. in cathodes, and 16.25@16.35c. for casting copper. The United States production of copper for the five months ending May shows a decrease of 1,049 tons, or 1.1 per cent; the exports for the same period show a decrease of 35,458 tons, or 48.2 per cent, as compared with the corresponding period of 1900. The business failures last week, as compiled by *Bradstreet's*, numbered 188, which was the same number as reported the week previous. The corresponding week last year the number was 167.

ELECTRIC TRAVELLING CRANES.—Pawling & Harnisch-

World's Work for July gives a graphic explanation of how Wall Street has become a perfected mechanism for the handling of money; how it trades; the means concerned; its bankers, brokers, speculators and rogues; the details of its service, its expenses and all its various methods of doing business. The idea of the rush of life Mr. Nelson gives in a striking incident. To illustrate how quickly the news is delivered, the last Chicago, Milwaukee & St. Paul dividend meeting can be recalled. There was doubt about the rate. The old rate was 5 per cent a year; an advance to 6 was expected. Each news bureau had two men in the St. Paul office, 30 Broad Street, waiting for the adjournment of the directors. Each one of the three had secured control of a telephone and the wires were cleared to the home office of the news bureaus. In the meantime the bureaus had not been idle; each one had three sets of bulletins (covering any possible emergency) printed. All the bulletins were distributed at various stations througout the Wall Street district. Finally a man in the St. Paul office walked out and said: "The semi-annual dividend is 3, an advance of ½ per cent!" There was a mad scramble for the telephones. Each news bureau received its bulletin one minute after the announcement. At the same time fast messengers were despatched to the relays of boys stationed at various points telling them to "cut loose" with Bulletin No. 3, and so the St. Paul dividend was in every Wall Street office a very few minutes after it was announced.

AMERICAN SALESMAN ABROAD.—Consul Marshal Halstead sends from Birmingham some crisp criticism of American business men who think foreign trade is to be had for the asking. He says: "American manufacturers and merchants frequently open correspondence with United Consuls with the sentence, 'Being desirous of taking advantage of the rapidly growing demand for American products, etc.' There is for American goods no foreign demand of the 'shake the tree kind' these inquirers have in mind. The sales of our goods of all kinds are based on the merits and low prices of the articles, after energetic salesmen have made active demonstration of good points. I cannot understand the mental attitude of those American manufacturers who employ traveling salesmen to get trade in America, paying good salaries and allowing liberal sums for traveling expenses, yet wish to do business by correspondence in foreign countries. Why do they imagine they can trade successfully in Great Britain, Germany, or any other European country without employing their own travelers, when the necessity of having them is the first principle of their home business?" It may be pointed out, however, that American export goods are largely in the hands of foreign commission agencies, selling houses, local companies, etc.

GERMAN FINANCE.—A special cable dispatch from Berlin, of June 23, says: "More buying was done upon the Boerse yesterday, although cautiously, than had occurred in a long time. The favorites were the North German Lloyd Line and the Vulcan Shipbuilding Company, of Stettin. The shares of the electrical companies also were active. Notable among these were the Schuckert Electrical Company, of Nuremberg, the Hagen Electric Accumulator Company, the Boerse Electric Accumulator Company, the shares of which rose 11½ points; the Allgemeine Elektricitaets-Gesellschaft, of Berlin, and the Frankfurt Electrical Company. The increased activity in these securities is all the more remarkable because the first part of the week brought the bad news of the failure of the Kummer Electric Company, the announcement of which led to the collapse of the Saxon Accumulators System, and the branches of the concern at Teplitz and Leitmeritz." This week has come the news of the failure of the Leipziger Bank with a capital of over $11,000,000, due to the distress in the industrial markets. It is said to have been largely engaged in street railway enterprises.

POWER TRANSMISSION IN NEBRASKA.—On June 19 articles of incorporation were filed with the Secretary of State, Lincoln, Neb., for the incorporation of the Omaha Suburban Railway and Traction Company, with a capital stock of $500,000. The incorporators are well-known Omaha and Fremont capitalists, A. C. Foster, L. C. Lloyd, M. H. Hinman, J. F. Hanson and T. W. Blackburn. Omaha, South Omaha, Blair, Fremont and Plattsmouth are named as the termini of the road, headquarters of which will be in Omaha. The power plant necessary to operate the line is to be erected in connection with the gigantic reservoir to be built in the neighborhood of Fremont. A canal 30 miles long and 100 feet wide at the top will conduct the water from the Platt River to the reservoir. The dam 100 feet high at the highest point will be necessary to form the reservoir. The reservoir, canal and power plant are said to cost approximately $1,000,000. It will be constructed and operated under a separate company, for which the articles of incorporation have not yet been filed. Current is also to be transmitted to adjacent cities for power purpose. Omaha and South Omaha are at present using more than 50,000 hp of steam, which will mostly be displaced by electrical power transmitted from this plant.

AMERICAN AUTOS IN ENGLAND.—The City and Suburban Electric Carriage Company of London wrote an interesting letter this month to the Electric Vehicle Company, showing the popularity of American automobiles in England. One passage of it runs as follows: Her Majesty the Queen, who has been using one of your Mark XII Columbia Victorias for the past twelve months, which vehicle was supplied by ourselves, is extremely pleased with it, and we were granted the especial privilege of showing it at the Automobile Exhibition last month, where it attracted considerable attention. We are getting the vehicles placed with the very best people, such as the Earl and Countess de Grey, the Countess of Gosford, Baron Alfred de Rothschild, Baron de Meyer, and others of the aristocracy, all of which is popularizing the vehicles in the fashionable world.

THE JAPANESE HOUSE of Takata & Company, New York offices, 10 Wall Street, has just placed a contract for one of the smallest complete electric lighting plants ever shipped from the United States. The plant will be installed in the Kitahama Bank in Osaka, Japan. It will consist of a 10-kilowatt direct current engine type generator, which will be direct connected to a 6 by 8 single cylinder engine. The first named machine will be built by the Westinghouse Electric & Manufacturing Company, while the engine is to be Erie Ball make. There will be a complete Westinghouse generator panel switchboard. A 15-hp boiler is to be furnished by the Babcock & Wilcox Company. A 2 x 1¼ x 2¾ Knowles feed pump is to be supplied by the International Pump Company, and a 25-hp Wainwright heater will also be utilized.

ORDERS FOR TELEPHONE EXCHANGES.—Among the many contracts for telephone plants recently closed by the American Electric Telephone Company of Chicago, we note the following: Mansfield, Ohio, common battery, 1,200 installed, with provision for 3,000; Reading, Pa., central energy, 1,500 lines with 5,000 ultimate capacity; Zanesville, Ohio, common battery, 1,200 connected, with 3,000 ultimately; Huntington, Ind., 300 at present, to increase to 1,500; Austin, Tex., with 1,200 for immediate connection, 3,000 ultimately; Temple, Tex., and Tyler, Tex., 600 ready to connect, will provide for increase to 1,500; Xenia, Ohio, 600 in operation, provision for 2,000, and Oklahoma City, Ind. Ter., 750 subscribers on 1,200 line switchboard.

VICTOR TURBINES FOR CANADA.—The Stillwell-Bierce & Smith-Vaile Company, of Dayton, Ohio, have just secured a large order for Victor high pressure turbines from the Quiatchouan Pulp Company, Quiatchouan, P. Q., Canada. It includes two 1,000-hp Victor high pressure turbines, one 500-hp Victor high pressure turbine, and one 100-hp Victor high pressure turbine. The two 1,000-hp wheels drive the grinders, the 500-hp wheel is to drive the screens and wet machines, and the 100-hp wheel is for electric lighting purposes. The order was secured by Mr. Clarence Folsom, engineer. The wheels will work under 240 feet working head and the pulp mill will have a capacity of 30 tons daily.

THE LORAIN STEEL COMPANY, of Lorain, Ohio, continue to capture contracts for tramway rails required by various British municipal corporations. Besides securing important contracts for Glasgow, Dundee and Halifax, the Ohio mills have just been awarded rail orders for Ayr, Scotland, Newcastle-on-Tyne, and Darwen, a town in the vicinity of Blackburn, Lancashire.

MR. LAWRIE, of Bulwer, Lawrie & Company, Calcutta, is at present in this country with a view to purchasing considerable electrical machinery, etc. He may be reached through the New York Export & Import Company, of 56 Pine Street.

BOROUGH ENGINEER LORD, of the important city of Halifax, England, reference to whose visit to this country was noted in these columns last week, when seen at the Fifth Avenue Hotel by a representative of the ELECTRICAL WORLD AND ENGINEER gave some interesting information regarding pending contracts in relation to the municipal electric traction system of that Yorkshire city. He said: "We now have in operation about 30 miles of track, which is to be extended until we shall have 57 miles of road in operation. About two years ago Mr. Whitney, the then chairman of the tramway committee, accompanied by Mr. Steele, the electrical engineer of the Halifax tramways, visited the United States and made a somewhat exhaustive inquiry into American electric traction methods, with the result that several contracts for material equipment, etc., have been placed with your manufacturers, and a goodly portion of the orders to be placed in connection with our present extension will find its way to the United States. Just before I left England our tramway committee placed a contract with the British Westinghouse Electric & Manufacturing Company for 72 single electric motor equipments of 35 hp each. These, I understand, will be made in America, as the British Westinghouse plant, of Manchester, is not yet in working operation. We shall want at least 8,000 tons of rails and as British mills cannot undertake contracts at the present time for prompt delivery, and moreover because we can purchase rails cheaper on this side, our orders in that direction are more than likely to be closed with Americans. We shall also be shortly in the market for a 600-foot span bridge 60 feet wide, which we anticipate will mean an expenditure of some $400,000. As the Halifax Corporation is not prejudiced in any way and buys where it can do so to the greatest advantage, American bridge builders will have an opportunity to figure on this contract. The last bridge we erected was of Belgian make. As our city is situated in a hollow surrounded by mountains, something like Pittsburg, we have many inclines to traverse. Our gradients average 1 in 9.5. While in Cincinnati and Pittsburg I was considerably interested to see how the cars are operated on the steep portions of the lines, and we shall inaugurate an almost similar system, with the exception that we shall employ electricity in connection with the platforms instead of steam, as is used out West."

ELECTRIC TRAVELING CRANES.—Pawling & Harnischfeger, Milwaukee, Wis., report business well up to the average of last year. Their recent sales of electric traveling cranes are: Midvale Steel Company, Philadelphia, Pa., one 60-ton, with 15-ton auxiliary hoist; one 30-ton, with 10-ton auxiliary hoist; two 25-ton, one 15-ton, one 10-ton, with 3-ton auxiliary hoist. Wheeling Mold & Foundry Company, Wheeling, W. Va., two 20-ton, one 10-ton. Hood Machine Company, Birmingham, Ala., one 12-ton. Mountain Copper Company, Keswick, Shasta County, Cal., one 25-ton. New York Shipbuilding Company, Camden, N. J., duplicate order for one 15-ton (double trolley). United States Government, new printing office, Washington, D. C., one 25-ton. E. Hodge & Company, Boston, Mass., one 15-ton. National Steel Casting Company, Montpelier, Ind., one 20-ton, with 5-ton auxiliary hoist. Erie City Iron Works, Erie, Pa., one 25-ton, with 5-ton auxiliary hoist; one 10-ton. Vilter Manufacturing Company, Milwaukee, Wis., one 30-ton, one 15-ton. Wisconsin Bridge & Iron Company, No. Milwaukee, Wis., one 15-ton. Butte City Water Company, Butte, Mont., one 20-ton (double trolley). Waterbury Farrel Foundry & Machine Company, Waterbury, Conn., one 20-ton.

GENERAL ELECTRIC IN ENGLAND.—The General Electric Company has purchased the German and French share holdings in the British Thomson-Houston Company, Limited, of London, England, thereby giving the General Electric Company the controlling interest. President C. A. Coffin, First Vice-President Eugene Griffin, and General Manager of the Foreign Department W. J. Clark, of the General Electric Company, will be members of the British Thomson-Houston board, and it is announced that the closest cooperation will exist between the General Electric and British Thomson-Houston Companies. The British Thomson-Houston Company was originally a licensee of the Thomson-Houston Company of America, and has been operating under patents of the General Electric Company, but as an independent concern. Parent company interests have, however, for some time held stock in the British company, which of late has been in need of the change now made.

WESTINGHOUSE IN ENGLAND.—A special dispatch from London, of June 21, says: The *Daily Mail* prints a long description of the progress of the Westinghouse factory which is being built at Trafford Park, Manchester. It says the factory will be an immense hive of British industry, directed by American brains. The American contractor, Mr. Stuart, is employing labor saving devices and is teaching and leading 2,600 British workmen so effectually that, while there is no hurrying or shouting, there is a steady, quiet progress. There is no loafing, the men working all the time. Mr. Stuart has taken a liking to his British employees. He says he finds the skilled labor good, but he regards the common laborer as a poor creature compared with an American of the same class. A village is springing up alongside the works, which are to be arranged on American plans and will be heated by gas and lighted by electricity. The correspondent says the village will be a "pocket edition" of Pittsburg.

THE NEW PROCESS RAW HIDE COMPANY, Syracuse, N. Y., reports the export sales of its pinions as rapidly increasing. The company has recently shipped 100 electric railway pinions for G. E. 800 motors to London on an order from an electrical supply house in that city. The pinions are to be used on one of the big railways recently built there. A shipment of pinions has also been made to the Albion Motor Company, an English automobile company. In the general machinery line the company has just shipped a number of big bevel gears, both iron and raw hide, some of the latter as large as 32 inches diameter, to a large English ship building concern. A number of railway pinions have been shipped to Germany and Norway, and reports from those countries say that the demand for them is increasing. Several inquiries for catalogues and prices have lately been received from Japan. A good sized order is in process of construction for one of the mines at Kalgourlie, Australia.

BROOKLYN RAPID TRANSIT EQUIPMENT.—The Brooklyn Rapid Transit Company is preparing to use compressed air to some extent in the operation of several of its lines. A compressed air plant is to be established by the company in the neighborhood of the Brooklyn terminal of the big bridge, and compressed air is to be supplied to some of the cars on the Brooklyn elevated and surface roads by the Compressed Air Company of Manhattan. The system to be used is said to be an improvement on that tried in Manhattan, and if it proves a success it will be used permanently on some of the Brooklyn roads. President Greatsinger, of the Brooklyn Rapid Transit Company, said last week that since he was made the head of the road, on March 20 last, $3,200,000 had been laid out by the company for new cars, generators, sub-power stations, and other improvements.

EDISON BATTERY FACTORY.—A deed filed in the Essex County Court House, New Jersey, records the sale of the Hayden estate in Bloomfield Avenue, Glen Ridge, to Thomas A. Edison, for $19,000. The land is part of a plot on which Mr. Edison intends to erect a plant for the manufacture of his recently invented storage battery. The property is 200 by 580 feet. On the property are several brick buildings, which are to be removed within a week or so. Ground then will be broken for the factory. Wealthy residents of Glen Ridge do not want a factory on the site and have used every effort to prevent Mr. Edison from obtaining control of the property.

ROBERT W. BLACKWELL & COMPANY.—The British electrical engineering and contracting firm of Robert W. Blackwell & Company, Limited, continues to place substantial contracts for overhead equipment, etc., required by various English traction systems. The New York office of the company is about to make shipment of some 700 tons of trolley poles for the Bradford and Manchester Corporation tramways. The poles are being turned out by the Morris-Tasker (Philadelphia) Works of the National Tube Company.

THE STANLEY ELECTRIC MANUFACTURING COMPANY has voluntarily granted its employees a 9-hour working day with 10 hours pay, besides a 5 per cent increase in wages. New shops have recently been completed at Morningside, one mile out on the line of the Boston & Albany Railroad, and sufficient orders are reported already in hand to keep these running day and night for the ensuing year. President Perrine made the statement this week that at present 500 hands are effected by the change. The company has the reputation of being very liberal with its employees.

W. R. STEELE, of Burn & Company, Limited, Calcutta, which concern is one of the most prominent handlers of electrical apparatus, machine tools, etc., in the British East Indies, is now in the United States for the purpose of placing substantial contracts. He is at present in Cincinnati, but will have returned to New York, according to present arrangements, June 24. Mr. Steele purports visiting Philadelphia on the 26th inst. While in New York he will reside at the Holland House.

PAPER MILL IN FRANCE.—Mr. H. S. Van Buren, U. S. Consul at Nice, France, in reporting on paper mill industry, states that a company has been formed to take over the paper mill at Point de Peilles, establish it in the Var region and develop water power for electrical purposes of not less than 100 hp.

SIPE & SIGLER, of Cleveland, report that they have been awarded a contract for a battery of 64 storage cells of 800 amp. hour capacity, to be installed at the Schuylkill Arsenal, Philadelphia.

The Berliner Telephone Patent Decision.

CIRCUIT COURT OF THE UNITED STATES, DISTRICT OF MASSACHUSETTS.—IN EQUITY.

No. 653.—AMERICAN BELL TELEPHONE COMPANY, COMPLAINANT, *vs.* NATIONAL TELEPHONE MANUFACTURING COMPANY ET AL., DEFENDANTS.

No. 655.—AMERICAN BELL TELEPHONE COMPANY, COMPLAINANT, *vs.* CENTURY TELEPHONE COMPANY ET AL., DEFENDANTS.

ATTORNEYS.—Fish, Richardson & Storrow, for American Bell Telephone Company; Edward P. Payson for National Telephone Manufacturing Company; James E. Maynadier for Century Telephone Company et al.; Robert S. Taylor also argued for defendants.

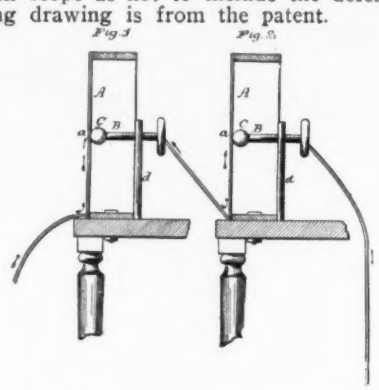
OPINION OF THE COURT, JUNE 24, 1901.

BROWN, J. These suits are for infringement of Letters Patent No. 463,569, issued Nov. 17, 1891, to the American Bell Telephone Company as assignee of Emile Berliner. The patent states that the invention consists

"in a new and useful improvement in transmitters for electrically transmitting sound of any kind."

The defendants contend that the patent is invalid, and that Claims 1 and 2, on which the complainant relies, are either invalid or so limited in scope as not to include the defendants devices.

The following drawing is from the patent.



DRAWING FROM BERLINER PATENT.

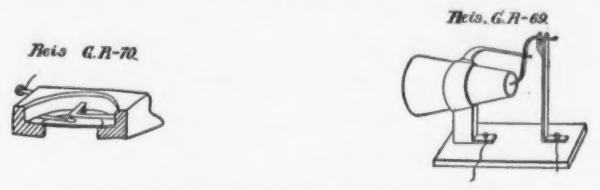
The invention is thus described in the specification:

"It is a fact that if at a point of contact between two conductors forming part of an electric circuit and carrying an electric current, the pressure between both sides of the contact becomes weakened the current passing becomes less intense—as, for instance, if an operator on a Morse instrument does not press down the key with a certain firmness the sounder at the receiving instrument works much weaker than if the full pressure of the hand had been used. Based on this fact I have constructed a simple apparatus for transmitting sound along a line of an electric current in the following manner:

"In Figs. 1 and 2 of the drawing, A is a metal plate well fastened to the wooden box or frame, but able to vibrate if sound is uttered against it or in the neighborhood of said plate. Against the plate and touching it is the metal ball C, terminating the screw-threaded rod B, which is supported by the bar or stand *d*. The pressure of the ball C against the plate A can be regulated by turning the rod B. The said ball and plate are included in circuit with an electric battery, so that they form electrodes, the current passing from one of them to the other. By making the plate vibrate the pressure at the point of contact *a* becomes weaker or stronger as often as vibrations occur, and the strength of the current is thereby varied accordingly, as already described. By placing now, as is shown in the drawings, one such instrument in the station Fig. 1, and another instrument capable of acting as a telephonic receiver in the station Fig. 2, both situated on the same electric circuit in which a current is passing (as shown by the wire connections following the arrows), sound uttered against the plate of the instrument Fig. 1 will be reproduced by the plate of the instrument Fig. 2, for as the vibrations of the transmitter Fig. 1 caused by the sound will alternately weaken and strengthen the current as many times as vibrations occur, the diaphragm of the receiver will be caused by these electrical variations to vibrate at the same rate and measure. The latter vibrations being communicated to the surrounding air, the same kind of sound as uttered against the transmitter Fig. 1 will be reproduced at the receiver Fig. 2, or in as many other receiving-instruments as are situated within the same electric circuit.

"It is not essential that the plate should be of metal. It can be of any material able to vibrate, if only at the point of contact suitable arrangement is made so that the current passes through that point. The plate may be of any shape or size, or other suitable vibratory media may be used—a wire, for example. Any other metallic point, surface, wire, etc., may be substituted for the ball. There may be more than one point of contact to be affected by the same vibrations. Both of the electrodes may vibrate, although it is preferable that only one should. If the uttered sound is so strong that its vibrations will cause a breaking of the current at the point of contact in the transmitter, then the result at the receiving instrument will be a tone much louder, but not as distinct in regard to articulation."

The drawing shows two distinct instruments. The transmitter, Fig. 1, is the subject-matter of the patent in suit. Its plate is vibrated by sound waves, and the vibrations produce electrical undulations. It is conceded by the complainant that the instrument of the patent is substantially the old Reis structure illustrated in the *Telephone Cases*, 126 U. S., pages 40, 53, 58, 60, 191, 196.



REIS TELEPHONE MAKE-AND-BREAK APPARATUS.

With this apparatus Reis, as early as 1861, transmitted musical tones. "He could sing through his apparatus, but could not talk," for the reason that he broke the contact of his electrodes and interrupted the current. The apparatus, however, under expert manipulation, is capable of transmitting speech, though this was not accomplished until after Bell's discovery that the true way to transmit speech was to operate on an unbroken current. 126 U. S. 540-545.

The receiver is represented by Fig. 2. Its plate is vibrated by electrical undulations, and the vibrations of the plate produce sound waves. The receiver is covered by another patent to Berliner, No. 233,969, dated Nov. 2, 1880. The claims in issue are as follows:

"1. The method of producing in a circuit electrical undulations similar in form to sound-waves by causing the sound-waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described."

"2. An electric speaking-telephone transmitter operated by sound-waves and consisting of a plate sensitive to said sound-waves, electrodes in constant contact with each other and forming part of a circuit which includes a battery or other source of electric energy and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of said sensitive plate."

The patent contains the following disclaimer:

"I do not claim that I am the first inventor of the art of transmitting vocal and other sounds telegraphically by causing electrical undulations similar in form to the sound-waves accompanying said sounds. Neither do I claim that I am the first who caused such electrical undulations by varying the resistance of an electric circuit in which a current was passing."

The last sentence has reference to Bell's variable-resistance method described in the *Telephone Cases*, 126 U. S. 531, 536, 537, 538, and covered by the following claim of Bell's patent:

4. The method of producing undulations in a continuous voltaic circuit by gradually increasing and diminishing the resistance of the circuit, or by gradually increasing or diminishing the power of the battery, as set forth.

On page 323 of 126 U. S. is shown "Bell's Centennial Liquid Transmitter," an instrument operating by the variable resistance method covered by claim 4 of Bell's patent 174,465, March 7, 1876.

Though Bell's patent made no claim for apparatus operating by this method, his specification contained this language:

"Electrical undulations may also be caused by alternately increasing and diminishing the resistance of the circuit . . .

"The external resistance may also be varied. For instance, let mercury or some other liquid form part of a voltaic circuit, then the more deeply the conducting-wire is immersed in the mercury or other liquid, the less resistance does the liquid offer to the passage of the current. Hence the vibration of the conducting-wire in mercury or other liquid included in the circuit occasions undulations in the current."

Prof. Wright, complainant's expert, says of this extract from Bell's patent:

"This described a liquid transmitter, and I believe that any one familiar with electrical science, and having a knowledge of the art as it was at that time, would have been able to construct an apparatus which could be used for the transmission of speech."

Speaking into the mouthpiece vibrates the diaphragm, whose movements cause the conducting wire attached to the diaphragm to move up and down in the liquid, thereby permitting more or less electricity to pass according to the extent of immersion. The liquid may be acidulated water or mercury.

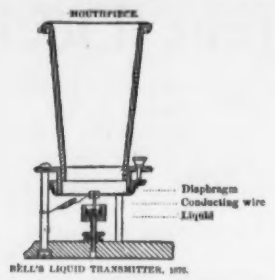
Professor Cross, complainant's expert, says that this was the apparatus with which Bell first successfully transmitted speech, and that "the apparatus was and is perfectly operative." It was exhibited at the Centennial Exhibition in 1876. Professor Cross describes the operation as follows:

"When the diaphragm vibrated the wire dipped more or less deeply beneath the surface of the liquid, so that that portion of the wire from which the current flowed into the liquid was alternately increased and diminished, thus increasing and diminishing the resistance at that place, and so producing electrical undulations."

A comparison of this instrument with that of Berliner's patent is of principal importance in this case. The defendants rely upon it, not as a complete anticipation of Berliner's instrument or invention, but as an anticipation of the broad claims of the patent, and

of the broad claims of the complainant's counsel and experts as to the character and importance of Berliner's invention.

It appears by Berliner's testimony that, before constructing his instrument, he had carefully studied Bell's first patent, and that the



BELL'S LIQUID TRANSMITTER.

metal plate or diaphragm A, of Fig. 1, was taken from Bell's second patent, 186,787, Jan. 30, 1877.

What appears in Bell's patents, or in Bell's liquid transmitter, cannot be claimed as novel with Berliner. Upon comparison, we find the following resemblances: Each is apparatus for practising Bell's art, process or method of "transmitting vocal or other sounds telegraphically. . . . by causing electrical undulations similar in form to the vibrations of the air accompanying. . . . vocal or other sound." Bell's patent, claim 5. The treatment of the current described in the Berliner patent is the same as Bell's. Each is apparatus for practising Bell's art by Bell's variable-resistance method, *i. e.*, "gradually increasing and diminishing the resistance of the circuit." Bell's patent, claim 4. The method of treating the resistance of the circuit is the same in each. Each receives the sound waves upon a diaphragm, which vibrates and effects changes in a circuit in which an unbroken battery current is passing, thus producing electrical undulations similar in form to sound waves. In each, there are electrodes in constant but variable contact. Each operates by a varying contact. In each, pressure is exerted upon the diaphragm by sound waves, and by one moving electrode upon another electrode; so that in each there is pressure between electrodes. In each, there is produced by the force expended upon the diaphragm a weakening and strengthening of the current, through the weakening and strengthening of physical and electrical contact of electroues. Bell's liquid transmitter is, therefore, a complete anticipation of Berliner's transmitter in these particulars: In the use of a battery current, instead of a current generated by the transmitter instrument, as in Bell's magneto instrument illustrated in Bell's patent. (See 126 U. S., page 5, Fig. 7.)

In the use of electrodes in constant contact with each other, and forming part of a circuit which includes a battery.

In the use of the pressure of one electrode upon another to strengthen an electrical contact, and of a relaxation of pressure to weaken the electrical contact.

It is, therefore, true, as the defendants contend, that claims 1 and 2 of the patent in suit, taken as they read in the ordinary sense of the words used, without limitation as to the size, shape, or materials of the electrodes used, are anticipated by Bell's liquid transmitter.

It may clear the discussion of this case if we observe that two distinct questions have been confused. Does Bell's liquid transmitter anticipate the first and second claims? Does Bell's liquid transmitter anticipate an invention made by Berliner?

The complainant misstates the position of the defendants, saying on its brief that "The National Company contends that the 'Bell liquid transmitter,' briefly referred to in Mr. Bell's great telephone patent of 1876, was a microphone and anticipated Berliner." The defendants do not so contend. The term "microphone," according to the complainant, denotes an instrument having solid electrodes. The defendatns do not contend that Bell's liquid transmitter was a microphone. To the defendants' assertion that the claims cover Bell's liquid transmitter, as well as Berliner's, the reply is that Bell's liquid transmitter does not anticipate Berliner's instrument nor Berliner's actual invention. This does not meet the true issue. The anticipatory effect of Bell's patent and of Bell's liquid transmitter cannot be ignored. The failure of the complainant to recognize this fully is a weak point in its argument.

It is clearly established that Bell was a prior inventor of a constant but variable-contact transmitter. It is also apparent that in every transmitter having a constant but variable contact of opposing electrodes (a contact varying according to the vibrations of a diaphragm), there must be, as an invariable and necessary accompaniment, a variation of pressure between the electrodes. Whenever, in transmitting sound, pressure is expended by one electrode upon an opposing electrode, there is varying pressure, whether the second electrode be of water or mercury, as in Bell's liquid transmitter, or of powdered carbon, felt saturated with water, or plumbago, as in Edison's devices, and whether the second electrode yields to the force exerted upon it, or resists this force. It is manifest, therefore, that when Bell invented a transmitter in which there was a varying contact between opposing electrodes, he also invented a transmitter in which varying contact was inseparably associated with varying pressure. To claim broadly variable pressure between electrodes is to claim in other words variable contact of opposing electrodes. The claims of the patent are such as could properly be made, if at all, only by the inventor of the first transmitter having a constant but variable contact of opposing electrodes, *i. e.*, Bell. As varying pressure is a uniform accompaniment of varying but constant contact of opposing electrodes, one who desired to define Bell's liquid transmitter, so as to distinguish it from the Bell magneto instrument, which had no electrodes in contact, or from the Reis transmitter (with an inconstant or broken contact), might do so by reference to either of the novel features of Bell, and say that its novelties were either "constant contact" or "variable pressure," or both. Either of the two names will distinguish a constant-contact transmitter from the Bell magneto instrument, or from the Reis apparatus when operated according to Reis's method. Definition by a single novel feature, under some circumstances, is quite as good as definition with a full enumeration of particulars, but it may lead to fallacy by creating two names for one thing. Berliner was not the inventor of the first constant-contact transmitter. His instrument cannot be distinguished from previous or subsequent constant-contact transmitters by referring to a single feature not novel with him, but possessed by several transmitters. Therefore he must point out, in his claims, some distinctive difference between his invention and what is disclosed in the Bell liquid transmitter, in order to show his advance in the art. His apparent difference is merely in apparatus, but his apparatus is so inefficient commercially that if his patent is to be construed merely as for apparatus, the complainant's case is hopeless on the issue of infringement. The complainant, therefore, rests its case upon the proposition that Berliner's invention was a "new mode of operation," and from this arise the principal difficulties in the case.

The complainant starts the search for novelty at Bell's magneto instrument, and at the instrument of Reis, and not from Bell's prior variable-resistance transmitter and, upon its brief, contrasts Berliner's apparatus with Bell's magneto transmitter and with the Reis transmitter, first saying of Bell's magneto transmitter:

"The apparatus of Mr. Bell was exceedingly perfect both in its theory and in the practical results which were reached by it. But the currents produced by the transmitter were extremely feeble, since the currents utilized were generated by the transmitter itself; and its motions, as it was actuated only by the sound-waves due to the voice, were but slight."

The brief then says, in italics, "Mr. Berliner remedied this defect," and made a new type of transmitter, which employs Bell's method of transmitting speech. "It is what is known as a variable-pressure contact transmitter. It operates not as did the magneto, to generate the undulatory current produced by the small amount of energy which the voice can communicate to the transmitter, but simply to impress upon the electrical current furnished from another source—practically a battery—variations in strength which correspond to the motions impressed by the voice upon the transmitter."

But this is true of Bell's liquid transmitter, and was true of it in 1876, when it was exhibited at the Centennial. Berliner's transmitter in this respect was not a "new type of transmitter," but merely a species of a new type of transmitter invented by Bell.

It is a remarkable fact that, in spite of the testimony of Professor Wright that the Bell patent sufficiently disclosed a liquid transmitter to enable a person skilled in the art to make one, and in spite of the testimony of Professor Cross that the Bell liquid transmitter was, and is, perfectly operative, the complainant should ignore the Bell patent and Bell's liquid transmitter, and explain Berliner's invention by saying that in Bell's magneto instrument the currents were very feeble, since they were generated by the transmitter itself, and by saying, in italics, "Mr. Berliner remedied this defect."

Such a contention cannot be sustained. Bell's patent suggested the use of a battery current, and Bell's liquid transmitter used it in 1876. Berliner's apparatus has never been used commercially and made no practical advance on Bell's magneto transmitter.

The error of attributing to Berliner the credit of an advance upon Bell in the substitution of a battery current for a current generated by the transmitter rendered necessary a foot-note to the brief:

"It is true, of course, that Mr. Bell also suggested in his magneto patent that he could produce an undulatory current by varying the resistance, but he had made no suggestion whatever that this could be done by varying the pressure between two electrodes in contact."

After the opinion of the Supreme Court in the *Telephone Cases* as to the variable-resistance method (126 U. S. 538, 246, 247), in explaining the importance of Berliner's work, counsel for the Bell Telephone Company call Bell's great patent "Bell's *magneto* patent," and ignore the instrument with which Bell first transmitted speech.

This is a confession of fundamental weakness in the complainant's case. It is essential to the complainant's argument that the true scope of Bell's variable resistance method, and of Bell's work in applying that method, should be ignored, in order that the Berliner patent may be construed as for a new "method" instead of for practically useless apparatus for practising the variable-resistance method of Bell.

The complainant further proceeds to show the nature of Berliner's invention by stating, as a main proposition on the brief, "Berliner's inventions do not reside in the structure involved." Berliner, "using substantially the old Reis structure," produced a "new mode of operation." In explaining this, the brief again ignores Bell's liquid transmitter and reverts to Reis, quoting the language of the Supreme Court to the effect that the question is "not as to the character of the apparatus, but as to the mode of treating the current of electricity on which the apparatus is to act." It refers to Berliner's "new electrical mode of operation," and also quotes the language of Professor Cross:

"Structure here is not the controlling element. In machines generally the operation and the result are absolutely controlled and defined by the structure and organization of the machine. But this simple contrivance is more like a tool, because it can be compelled at the pleasure of the operator to perform the breaking operation and produce the broken Reis current, or to perform the variable-pressure operation and produce the undulatory current."

Berliner's "new electrical mode of operation" or mode of treating the current is new as to Reis, because it has that novelty which the Supreme Court has decided to constitute Bell's advance upon Reis. His mode of treating the circuit is new as to Reis in that the contact is not broken—but this is Bell's novelty.

The complainant's patent does not refer to any new treatment of an electrical current, and disclaims novelty in causing electrical undulations similar in form to sound waves.

As a substantive part of its case, the complainant has claimed for Berliner as distinctive features the use of a battery current and constant contact of electrodes, both of which are Bell's. Although the patent expressly disclaims that Berliner was the first to cause electrical undulations by varying the resistance of an electrical circuit in which a current was passing, and disclaims novelty in the production of electrical undulations similar in form to sound waves, the brief in effect retracts this disclaimer by showing Berliner's novelty against a prior art, from which is excluded what the patent by its disclaimers acknowledges was old at the date of the application. Bell's liquid transmitter is not in the prior art of the complainant's case. The attempt to dispose of that apparatus by characterizing it as a mere laboratory experiment, after Professor Cross's evidence that it is an operative instrument, and after it was presented to the Supreme Court as a speaking telephone (126 U. S. 247, 322), is not successful. This instrument is quite as important after the expiration of Bell's patent as it was before. It was the primary instrument employing the variable resistance method, and after it the problem was to improve upon Bell's electrodes. Improvement upon the resistance of the circuit was not a new art or method. Whatever the particular kind of resistance, whether "contact resistance" or "mass resistance," the method of varying it is Bell's. I am of the opinion that upon Bell's liquid transmitter the defendants have established their first defense, to-wit:

"In the state of the art of electrical telephony in 1877, there was nothing in the Berliner transmitter of patent No. 463,569 patentable over Bell as an art (Claim 1), nor anything patentable as mechanism, unless in the substitution of a solid metal electrode for Bell's mercury electrode, which substitution only reproduced a Regnault or a Reis instrument, to be operated by Bell's method."

It appears also that there can be only two narrow grounds upon which the Berliner patent can stand:

1. That it was patentable to apply Bell's variable-resistance method to the apparatus of Reis.

2. That it was patentable to substitute a solid metal electrode for Bell's mercury electrode.

I am further of the opinion that these claims are invalid for excessive breadth, under the decision of the Supreme Court in the Incandescent Lamp Patent, 159 U. S. 465, 476, as attempting to monopolize the use of the pressure of one electrode upon another to effect changes in the circuit, and also as attempting to monopolize the use of apparatus operating by changes of contact between opposing electrodes; even if the electrodes be limited to solids.

Professor Cross, upon the *prima facie* case, was asked:

"Is the patent confined to any particular sizes, shape or materials of the electrodes? and replied that "The patent is not in any way thus limited. . . . There is no limitation as to this matter in Claims 1 and 2 of the patent."

In argument, counsel for complainant, in setting forth the "remarkable character of Berliner's invention," and its great importance, state:

"That this invention is broadly covered, and conceded to be broadly claimed in the patent in suit, is stated in this bill" (brought by the Government for the annulment of the patent); "'And your orator avers further that the broad claims of said patent cover in their scope *every form of constant-contact telephonic transmitter which it is possible to make;* and that, so far as can be foreseen, the possession of this patent, if it is valid, will continue to the respondent company without substantial diminution during the full term thereof the same close monopoly of the art of telephony in the United States which it has enjoyed under said patent to Bell 174,465.'"

I believe these claims to cover broadly all transmitters having variable-contact of opposing electrodes. They certainly are broad enough to cover every variable-contact transmitter that has been presented in this case.

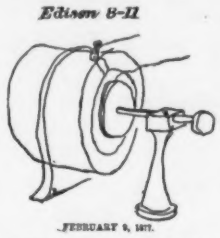
The concessions made by the complainant are sufficient to prove that these claims are what were termed in *Carlton* v. *Bokee*, 17 Wall, 471, "ingenious attempts to expand a simple invention of a distinct device into an all-embracing claim, calculated by its wide generalizations and ambiguous language to discourage further invention in the same department of industry and to cover antecedent inventions." It is a familiar rule that a generalization or definition that is too broad cannot be made good by making an arbitrary exception of each case that comes within its terms but which should not have been included. A single contrary example destroys the generalization.

The complainant claims broadly variation of pressure between electrodes in constant contact. This first conflicts with Bell's liquid transmitter. A liquid electrode is then excepted, but the exception of a liquid electrode still leaves the complainant claiming the mode of operation by variable contact for all electrodes other than liquids.

The claims limited to solid electrodes next come into collision with devices of Edison. The effect of these devices as anticipation will be considered later. We now consider them merely in connection with concessions of the complainant that the claims should not cover them.

This device has solid electrodes, and was an operative telephone in February, 1877. It is the basis of Edison's patent 474,230, applied for April 27, 1877. Its electrodes are a diaphragm of sheet metal, and a disk of hard rubber coated with plumbago, or a disk of some conducting metal or substance.

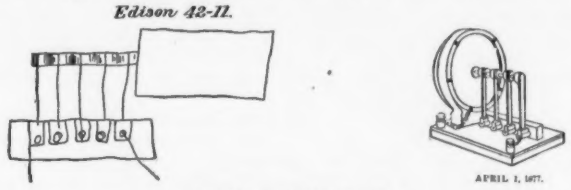
In this apparatus Edison employed a battery current and constant contact. There was variable pressure between solid electrodes as in Berliner's apparatus. The complainant excepts this from the Berliner patent by saying that it operates by varying surface



EDISON TRANSMITTER.

area of contact, and by varying the length of the path of the current outside of the area of contact, which is said to be different, theoretically and practically, from Berliner's method. It is, nevertheless, within the claims.

The claims are next confronted with apparatus of Edison dated April 1, 1877, which has solid electrodes. It consists of a dia-



EDISON TRANSMITTER.

phragm and "five vertical springs, each provided with a sleeve carrying a cylinder or button of hard-pressed plumbago fastened to a bar of insulating material. All the plumbago buttons were in contact, and the one at the end rested against the diaphragm. The circuit was complete from the first spring through all the carbons to the last spring." This the complainant says is not a variable-pressure transmitter, for the reason that Edison intended, by the vibration of the diaphragm, to compress electrodes of plumbago; thereby changing the molecular condition of the material of a part of the circuit. Counsel distinguish this, and impliedly limit the electrodes of the patent to solid electrodes having "transition resistance" due to a loose joint, by saying that the Edison device does not operate by variation of transition resistance. There can be no question but that, if Berliner had preceded Bell, Bell's liquid transmitter would infringe claims 1 and 2, both as to constant contact and variable pressure. If Berliner had preceded Edison, either of the devices shown would infringe the Berliner claims. The logical difficulty with the claims of the Berliner patent, in view of Bell's liquid transmitter and its position in the prior art, is that in attempting to define and mark out Berliner's novelty, they refer only to features that are common to Bell and Berliner, and not to the distinctive difference. It is definition "per genus," and not definition "per genus et differentiam," and the genus is Bell's. This is a defect not only of the claims, but of what may be termed the "variable-pressure" aspects of the complainant's argument. Practical accuracy, logical rules of definition and rules of law alike require that a definition shall include a statement of the distinctive difference. If we stop short of that, we err by being too vague. Though the complainant contends with great earnestness that Edison's devices are distinguishable from Berliner's, yet it is apparent that, in the same way that the claims fail to express a distinctive difference between Bell's liquid transmitter and Berliner's, they fail to express a difference between Berliner's and the devices of Edison.

To the objection that the claims are so broad as to include these devices, it is obviously no answer to reply merely that these devices are not analogous.

I am of the opinion, therefore, as the claims are statutory requirements, prescribed for the purpose of making the patentee define precisely what the invention is,—and as these claims are so broad as to include every transmitter of the general class of which Bell was the first inventor, and which is exemplified in his constant contact transmitter,—that they are invalid for excessive breadth, and for a vague generality which makes them a constant menace to all inventors who may seek to improve the art of telephony by applying what Bell has taught as to the practicability of operation by the constant but variable-contact method. This is also true if the electrodes are limited merely to solids.

By claiming "variable pressure of electrodes" as an art or method, the complainant seeks to monopolize an indispensable feature of every constant-contact transmitter having varying contact and opposing electrodes, and to suppress all subsequent invention in the same field. Walker on Patents, § 14. Counsel say that the method of operation by variable pressure is available "in the case of all electrodes which have surfaces between which there may be varying pressure." It is obvious that this language does not exclude even the liquid electrodes of Bell; and that, as all solids have surfaces of this kind, it includes the solid electrodes of Edison.

The final position of the complainant, upon the supplemental brief, is that the method of varying resistance in a battery circuit "by causing sound-waves to vary pressure between electrodes in contact" so as to "strengthen and weaken the contact" is a more specific and hence different thing from the mere effecting of "some physical changes in the path of the current."

Counsel fail to meet the actual contention that it is not a specific description sufficient to distinguish Berliner's method from effecting such physical changes in the path of the current as occur in Bell's liquid transmitter and in various devices of Edison.

I am of the opinion that the language of these claims is clear and that no resort to the specification is necessary to explain its meaning. They are not claims made in the infancy of an art by an unskilled inventor. They were put in the present form more than two years after Edison's carbon telephone had been placed on the market. They cover, if not every form of constant-contact transmitter which it is possible to make, at least every form that has been presented. They cover the use of variable pressure exerted by one electrode upon another, to vary the resistance of the circuit. They cover also all transmitters having a variable contact of opposing electrodes. They cover under a new form of words what was previously invented by Bell. To save these claims it is necessary, not to explain them by resort to the specification, but to ingraft upon them restrictive qualifications which the patentee omitted to point out.

This may not be done "for the purpose of changing it and making it different from what it is." *White* v. *Dunbar*, 119 U. S. 47; *Howe Machine Co.* v. *National Needle Co.*, 134 U. S. 388-394; *Paul Boynton Co.* v. *Morris Chute Co.*, 87 Fed. Rep. 225; *Day* v. *Fair Haven Railway Co.*, 132 U. S. 98, 102; *Merrill* v. *Yeomans*, 94 U. S. 568, 570; *Railroad Co.* v. *Mellon*, 104 U. S. 118; *Incandescent Lamp Patent*, 159 U. S. 465-472.

Later in this opinion, we will consider further the merits of the complainant's contention as to the importance and scope of what Berliner is said to have accomplished. Even if it be assumed that the complainant is lawfully entitled to the patent upon which its arguments are based, I am of the opinion that the argument by which the complainant seeks to show that the patent discloses an invention of broad character and scope is logically and legally unsound, and that what is described in the patent was, in view of the state of the art, of slight value and of narrow scope.

But before considering the reasons for this conclusion, we will consider the question of the validity of the complainant's title to the Letters Patent.

The case presents this remarkable feature,—that the application in terms denies that the instrument of the patent is adapted to the transmission of speech. The patent covers the transmission of speech by an instrument which the application does not describe as a speech transmitter, but, on the contrary, says is not adapted to the transmission of speech. Berliner's application filed June 4, 1877, was not for the invention covered by Letters Patent issued to the American Bell Telephone Company, as Berliner's assignee, on Nov. 17, 1891. Upon this question, we need consider only the single feature of "electrodes in constant contact" for speech transmission. The inquiry whether the application describes the "variable-pressure" method of Berliner is the same as the inquiry whether it discloses the constant but variable contact method of Bell, and whether it calls for the use of an unbroken current. The Supreme Court, in the *Telephone Cases*, 126 U. S. 544, 545, found that Bell discovered the true way to transmit speech; "to operate on an unbroken current by increasing and diminishing its intensity;" and that Reis, who preceded Bell, failed because he operated with a current made intermittent by the opening and closing of the circuit, saying:

"To follow Reis is to fail, but to follow Bell is to succeed. The difference between the two is just the difference between failure and success. If Reis had kept on he might have found the way to succeed, but he stopped and failed."

We shall find that Berliner did follow Reis, as a matter of fact, and that he failed, as a matter of fact, through attempting what was described by one of the examiners as a "kind of cross between the microphone and the Reis circuit-breaking operation." Our present question, however, is merely whether a document sworn to and filed by Berliner discloses a constant-contact speech transmitter, upon an examination of its text and drawings.

The examiner, on Jan. 31, 1882, decided that it did not; and filed on appeal before the Commissioner an answer which in my opinion conclusively shows that the invention disclosed in the application was not a speaking telephone, and not a constant-contact speech transmitter. The rejection of amendments by the examiner was overruled by the Commissioner, but it does not appear that he answered the specific reasoning of the examiner. A second examiner also made a ruling adverse to the amendments, which was reversed by the Board of Examiners on appeal, in a decision which stated:

"It seems to be clear from this review of the original specifications that, so far as can be judged from the language used, two things were disclosed by it; first, the transmission of musical sounds whether uttered by the human voice, as in singing, or produced by musical instruments; and, secondly, the transmission of speech by means of a make and break of contact through the use of the secondary device. It is to be noted, however, that even as to speech, Berliner's statement is merely that he had succeeded in reproducing the vowels and other special sounds."

The Board held, however, that the Commissioner's prior decision permitting amendment, bound the Board, and reversed the examiner. This opinion of the Board as to the meaning of the language used seems sound. While this Court is not bound by these decisions of the Patent Office, and looks to them merely as interpretations of this document referred to in both briefs, it may be said that the weight of reasoning is very decidedly with those officials who found that the application was not for a constant-contact speech transmitter, and that the weight of decision in the Patent Office upon the sufficiency of the original application is decidedly against the complainant.

We will consider this matter on its merits. A comparison of the two documents seems to me to settle this question.

There has been in this case a great abuse of the use of expert testimony. Experts have offered their views upon questions that are entirely outside their province. They have entered into argumentative discourses upon the meaning of a document which is plain upon its face and expressed in terms of ordinary speech that require no expert explanation. The question of the meaning of the text, and the question of mistake in writing the text, questions of fact as to the intention of the applicant when he wrote the text, evidence as to the state of the art having no bearing whatever upon the meaning of terms, and arguments as to the meaning of isolated portions of the text, have been so confused as to obscure the real questions.

Did the original document filed by Berliner, read as a whole, disclose the invention of the patent; did it disclose the fact that Berliner had discovered that speech could be transmitted with the instrument of the patent; did it show that Berliner had made any advance upon Reis, or intended to claim anything more for the instrument of the patent than the transmission of musical sounds? The question whether certain portions of this document were inserted through mistake, and whether, when amendments and corrections are made, the application discloses the invention, is, of course, an entirely distinct question that should not be confused with the present inquiry. The application referring to instruments substantially similar to those of the patent in suit says:

"If now the plate of one instrument, as in Fig. 3, is vibrated by sound waves (which happens whenever any kind of sound is uttered or produced by musical

BERLINER DIAGRAM.

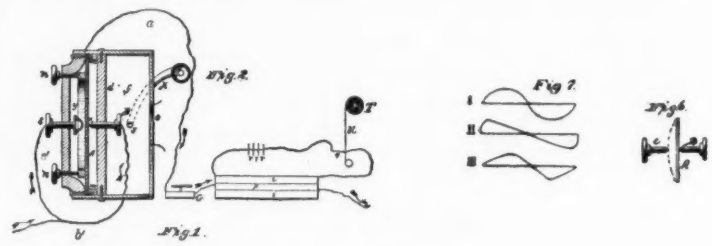
instruments in its neighborhood, every wave or vibration that strikes the plate will cause a weakening of the point of contact *x*, or also, if the sound is sufficiently strong, a break of the electric current at that point.

It is evident that changes thus occurring at the plate of one instrument will be noticed at the plate of the other, or in any such instruments that are situated within the same electrical connection; and as often as one plate is caused to vibrate just so often will the others vibrate, caused by the break or the weakening of the electrical current. The same kind of sound therefore which affects the plate of the first instrument will be reproduced by the plate of the others."

Immediately following this is a statement which seems conclusive of the question whether the application claims a constant-contact operation for speech transmission.

A statement by Berliner, under oath, on June 4, 1877, which, unless proven to be a clerical mistake, is fatal to the complainant, not only on the question immediately under discussion, but on the fundamental question of whether, in fact, Berliner invented a constant-contact speech transmitter:

"These simple instruments will reproduce any musical sound uttered in the



BERLINER DIAGRAMS.

neighborhood of one of them; but for the reproduction of special sound such as speech they are not adapted for the following reasons:

In accepting the graphical name of wave for a vibration we must consider the same to have two dimensions, length and depth or height. In Fig. 7 I have represented three sections of waves, all of the same length and height, yet they differ in shape and their highest point is not always situated in the centre of their length. Such is the case with sound waves of various kinds of sounds. In a pure musical tone the shape of the wave is entirely regular like in Section I, but in every other sound this is not the case. It is therefore evident that the apparatus described thus far can not but transmit a pure musical sound because it transmits only the number of vibrations per second which is equal to the lengths of the waves, but nothing of the nature of each wave and the shape of their curves is recorded."

The statement of the insufficiency of these instruments to transmit speech is accepted by the following description of the instrument, which was filed by Berliner as his model speech-transmitter:

"This I accomplish, however, by situating within the vibrating field of the plate A a second screw E. In Fig. 6 the dotted line indicates the vibrating field of the plate B, the screw in contact with the plate, and E, the second screw. It will now happen in special sounds (meaning the nature of every sound besides its certain musical pitch) that the plate will not always strike the screw E in the middle of the duration of one wave or vibration, and taking, for instance, the duration of one wave to be one minute, the plate in special sounds will sometimes strike the screw E sometimes after twenty or twenty-five seconds from its beginning. This, now, is exactly recorded by this secondary screw E, which also makes an electric connection whenever the plate A, touches it, and at the receiving apparatus these special sounds will therefore be noticed. I have thus succeeded in reproducing a great many special

sounds, such as the vowels and others. The principle of reproducing special sounds by break and make of contact rests mainly in the use of this secondary contact screw.

In the drawing the point of this second screw consists of a piece of spring steel bent in semicircle; this is sometimes advantageous, but not absolutely necessary.

It will be observed that this drawing shows, in connection with the two pins, a hearing tube K and a speaking tube O.

It is idle to contend that, with this portion of the specification retained, and read in connection with the claims and other parts of the specification, the application was for a constant-contact speech transmitter. Applying the legal rule that a document must be read as a whole, and reading it as it stands, it is fatal to the complainant's contention. The application expressly disclaims speech transmission by the instrument of the patent, and claims as a speech transmitter a double-pin instrument operating to make and break the contact of electrodes. Berliner's model filed with his application was a double-pin instrument. The patent calls for constant contact of electrodes and an unbroken current; the application for an interrupted contact and a broken current. The Supreme Court has decided that these methods are radically distinct. (126 U. S. 544, 545.) We can find nothing upon the face of this document that requires the Court, as a matter of construction, to reject any portion of the text, or to interpolate any words which the context proves to have been omitted. The complainant contends that the statement that the single-pin instruments are unadapted for the transmission of speech is inconsistent with other portions of the text. It is said that the phrase, "whenever *any kind* of sound is uttered or produced by musical instruments," is an assertion that speech is to operate the single-pin transmitter. But is this so? The word "uttered" is used in the following paragraph to indicate the production of musical sound, thus:

"These simple instruments will reproduce any *musical sound uttered* in the neighborhood of one of them, but for the reproduction of special sound, such as speech, they are not adapted."

The word "uttered" is used elsewhere in the application in the sense of produced. The Board of Appeals said, "The use of the word "uttered" in the latter part of the specification is significant, for, while it might appear from its use in the former part that it meant speech, this presumption is overcome by its use in the latter part in connection with musical sound." This is proper construction. The phrase has no reference to speech transmission. The word "uttered" being ambiguous, is to receive that interpretation which reconciles it with the rest of the text, rather than that which brings it into conflict therewith. It is then said that Berliner has stated that a "weakening of the current can be observed," and that changes at the transmitter that weaken the current can be observed at the receiver. But there is no inconsistency between the statement that weakenings can be observed and the statement that the instruments will not transmit speech. If some audible effects are referred to as produced by weakening the current, this is not speech. The document does not claim that, within the range of weakenings of the contact of the pin and diaphragm, speech can be transmitted; on the contrary, this is denied, and another inconsistent method is shown. Berliner has described the operation of the musical sound transmitter as a composite operation of weakenings and breaks of the current, saying that, "as often as one plate is caused to vibrate, just so often will the others vibrate, caused by the break or weaking of the electrical current." The statement relative to the irregularity of the sound waves and that nothing of the nature of each wave and the shape of their curves is recorded, applies to the composite operation and to both parts of it,—the weakenings as well as the breaks. The reproduction of special sounds is attributed solely to the supposed fact that the height of the waves is recorded by a contact with the second screw following a break of the circuit. It is said that the words, "any sound," include speech, and that therefore the subsequent statement that speech cannot be transmitted is inconsistent therewith.

But the words, "any sound," must be interpreted in connection with the specific exception of "special sound such as speech," which follows.

The contention that the particular clause is a contradiction of the general clause, is in effect a claim that a specific exception to a general statement should be rejected as inconsistent. We may test the validity of this method of construction by applying it to other text: "Of every tree of the garden thou mayst freely eat, but of the tree of knowledge of good and evil thou shalt not eat of it." Upon such a mode of construing text, the general permission is inconsistent with the special exception; therefore the exception should be eliminated. Such a mode of construction doubtless led to the fall of man. Legal rules of construction require that particular force be given to the specific exception. (*Bock* v. *Perkins*, 139 U. S. 628, 634, 637.)

It is further contended that the passage read as it stands would "make nonsense of the first three claims, which would be for inoperative combinations; the first of which would be entirely indistinguishable from the Reis transmitter, and the other two substantially indistinguishable." But this is not so. The first claim of the original specification is as follows::

"1. An instrument for transmitting and reproducing sound-waves by the agency of electricity, consisting of a metallic diaphragm or other vibratory medium connected to or forming part of one pole of an electric circuit and arranged in contact with the opposite pole thereof, and capable of being put into vibration by the action of the electric current as set forth."

The second is substantially the same. If this claim as counsel for the defendants contend, is a claim for a receiver only, there is certainly no inconsistency. The words, "capable of being put into vibration by the action of the electric current," have no application to a transmitter, and support this view. The complainant relies, however, upon the words, "for transmitting," to overcome the force of this clause.

In *United States* v. *Bell Telephone Co.*, 167 U. S. 264, it was said: "In a sense the receiver is also a transmitter, for it passes the sounds from the wire to the ear." If, then, we should find, that reading this claim as for a transmitter, it was inconsistent with other portions of the text, we should, as a matter of construction, avoid this inconsistency by interpreting the word "transmitting" in the sense referred to in the opinion of the Supreme Court, following the rule that the text should be harmonized if possible. But, on the other hand, the claim can be read as for both a transmitter and a receiver without encountering any inconsistency. The single-pin transmitter's functions are described elsewhere as the production of musical sounds. A claim is not nonsensical that describes an instrument both as a receiver and as a transmitter of musical sounds, even if the instrument as a transmitter is substantially the Reis transmitter. Many patents describe and claim in clear language that which has been invented previously; they cannot, for that reason, be characterized as nonsensical.

The third claim of the application is:

"The combination in one circuit of two or more vibratory diaphragms and contact pins adapted to operate similarly for the production and transmission of sound-waves when one diaphragm is caused to vibrate by means of any sound, as substantially as set forth."

This last clause makes particular reference to the specification and limits the function of the two instruments to the transmission of musical sound. A novelty is shown in the claim, and there is no nonsense here. There is nothing on the face of this text that requires us either to reject any part of it or interpolate anything as omitted.

Reading this document by itself, it is clear and consistent. Upon the view that there was no intention to describe or claim a constant-contact speech transmitter, there is no inconsistency or confusion. When we attempt to read it as for a constant-contact speech transmitter, then all is confusion, inconsistency and contradiction. The complainant contends that the patented invention was both described and claimed in the application before a word was altered by amendment; but, in support of this contention, argues that there was error in the expressions used and mistake in the text.

In considering whether portions of this document disclose a constant-contact mode of operation for the transmission of speech, the complainant contends that the specification was addressed to a person skilled in the art, and that this person would have known that there was no novelty in make and break of contact, and that speech could not thus be transmitted. It is then argued that for this reason the language must be interpreted as if the breaks were referred to as accidental. But surely such an assumption could not authorize us to reject an express statement by Berliner in this very document that he was attempting to reproduce special sound "such as speech" by make and break of contact; and that he had thus succeeded in reproducing a great many special sounds, such as the vowels and others. The document itself, on its face, disposes of the assumption, for purposes of construction, that Berliner knew better. Circuit breaking by two pins was new, not old. Berliner claimed it for speech transmission; and shows in his drawings a circuit breaker provided with a mouth-piece and ear-piece, and refers to this instrument when he says that "the operator is not in need of handling the instrument sidewards or moving his head while a conversation is carried on." And there seems to be no substantial ground for the statement of Professor Cross that the "circuit-breaking operation was known to be old, worthless and incapable of producing speech." The examiner considered many applications for circuit-breaking apparatus as late as 1882; and it appears that a circuit-breaking transmitter was greatly desired in order to avoid the Bell patent.

But even did the document elsewhere on its face fail to disclose the fact that Berliner was attempting a make-and-break operation, and were we simply construing those passages that relate to the single-pin instrument, we could not reject a distinct statement because it was erroneous as a statement of fact.

The attempt to construe this instrument according to supposed knowledge of the art completely fails, because Berliner expressly states that he thought otherwise than the expert is supposed to think, as well as because, on a question of the construction of text, a reference to the state of the art is permitted only for purposes of explanation and not to contradict plain language. In *Simpson* v. *Holliday*, 1 L. R. Eng. & Irish App. 315, 322, it was said:

"This does not warrant us in giving effect to a specification claiming two things, one practicable and the other impracticable, because a skilful workman would know that one of them could not be acted upon and so would confine himself to the other. This would not be to construe a specification according to the language of workmen instead of according to our ordinary language, but to reject something claimed by the patentee, because a workman would know that it was an unjustifiable claim."

In *Clark* v. *Adie*, 2 App. Cases, 436, Lord Blackburn said:

"When it is attempted . . . to say that inasmuch as these specifications show, or are alleged to show, matter which, upon a fair construction of the specification claimed by the patentee, were old at the time that the patent was taken out, and were generally known to be old, therefore the specification must be so construed as not to include them; that seems to me to be both contrary, so far as I know, to the cause of decision and contrary to principle. . . . It would afford a very simple recipe for saying that no patent should ever be upset upon the ground of want of knowledge. If, when you say you can show that a thing was old at the time the patent was granted, you are to construe the specification as not intending to claim that, because the man who claimed it would be suicidal and foolish, it would be a recipe for saying you shall never upset a patent at all for want of knowledge."

The question which counsel undertake to argue is, What does the document say? This is a question entirely distinct from the question of what it might have said or what it should have said, and from the question of mistake. In *Badische Anilin und Soda Fabrik*

v. *Kalle*, 94 Fed. Rep. 169, upon the question whether a certain document disclosed an invention so as to constitute an anticipation, it was argued that a certain statement was a mistake. Judge Coxe said:

"The court has simply to consider what the publication in question has contributed to the art. If it fails to show the invention which it is said to anticipate, the contention that its author knew enough to write an anticipation and intended to do so is grotesquely irrelevant."

The argument whereby the complainant endeavors to show that the original application could support the patent in suit, is a labored attempt to place upon plain and unambiguous language forced interpretations which do not explain, but destroy its natural signification,—interpretations which do not explain, but contradict. I am of the opinion, therefore, that the patent in suit cannot depend upon the original application, since it is for an invention radically distinct from anything described or claimed in the original application.

The radical difference between a make-and-break transmitter and a constant-contact transmitter having been shown by the decision of the Supreme Court, in 126 U. S., the next question to be considered is whether the original application could, under legal rules, be so amended as to serve as the basis of the patent in suit. The Supreme Court, in *Railway Company* v. *Sayles*, 97 U. S. 563, said:

"If the amended application. . . . embodied any material addition to or variance from the original,—anything new that was not comprised in that—such addition or variation cannot be sustained on the original application. The law does not permit such enlargements of an original specification, which would interfere with other inventors who have entered the field in the meantime, any more than it does in the case of reissues of patents previously granted. Courts should regard with jealousy and disfavor any attempts to enlarge the scope of an application once filed, or of a patent once granted, the effect of which would be to enable the patentee to appropriate other inventions made prior to such alteration, or to appropriate that which has, in the meantime, gone into public use."

In no case can there be stronger reasons for applying this rule than exist in the present case. See also *Hobbs* v. *Beach*, 180 U. S. 383, 396.

I am of the opinion that this patent is invalid for the reasons that the power to amend an application does not include the power to change the nature of the invention; that the right to amend or the right to complete an application under Section 4894 does not give the right to transform completely; that the only remedy for a radical mistake in substance so serious as to require a transformation so complete as is here shown is a new application. Robinson on Patents, Sections 561, 635; *Consolidated Elec. Lt. Co.* v. *McKeesport Elec. Lt. Co.*, 40 Fed. Rep. 21-27; *Railway Co.* v. *Sayles*, 97 U. S. 554-563; *Michigan Cent. R. R. Co.* v. *Consolidated Car Heating Co.*, 67 Fed. Rep. 121.

The first amendment affecting this controversy was made by Berliner on August 8, 1877, when he struck out the passage denying that the single-pin instruments could transmit speech, and also the claim for the double-pin instrument. The complainant contends that the application thus amended was a sufficient basis for the patent in suit. Assuming that the August amendment amounts to an assertion: "My single-pin instrument can talk. I strike out the reasons why it can't, and also the double-pin instrument, which for these reasons I previously said could talk;" here is a positive and clear contradiction of the former application, and the introduction of matter radically distinct. If this amendment is to bear this construction, I agree with the learned counsel for the defendant, that "probably no such flagrant instance of an application filed for one thing and then contradicted into its very opposite,— * * * —can be found in the books." If this was the effect of the amendment, it was clearly inadmissible.

Between the date of Berliner's application, June 4, 1877, and his amendment of August 8, there appeared a publication in the Philadelphia *Press* of July 9, 1877, in which was described a constant-contact variable-pressure speech transmitter, the invention of Edison. The apparatus included a diaphragm with a plumbago electrode in contact therewith.

"This, again, is another original discovery of Mr. Edison's, viz., that plumbago changes its electrical resistance with enormous rapidity under pressure, the effect in this application being that when the diaphragm is vibrated weakly contact is made with the plumbago point very lightly, and the resistance of the plumago being but slightly reduced a weak current is sent out from the battery, and a weak effect produced at the receiving station. When, however, a strong pressure of the diaphragm is effected by reason of the exercise of a more powerful vibration of the voice, the resistance is very greatly reduced and a strong current passes to the line and and a strong or loud effect is produced at the receiving station. Hence the amount of power, with all its fine gradations generated by the voice at the transmitting station, is transmitted in its proportions to the receiving instrument, and thus the fine articulation of the voice is obtained."

On July 20, 1877, Edison filed an application for Letters Patent No. 474,231, which covers completely all that is now claimed for Berliner, see 126 U. S. 378. It is apparent that amendments filed after this would interfere with another inventor, and that Berliner's amendment must, in any event, bear date as of August 8, 1877, and cannot relate to the date of filing the original application. But the contention that the amendment of August 8 made the application a sufficient basis for the patent in suit is unfounded. Striking out the only speech transmitter claimed did not introduce a new speech transmitter. The mode of operation remained unchanged,—"as often as one plate is caused to vibrate, just so often will the others vibrate caused by the break or the weakening of the electrical current." If by amendment it was intended to claim the single-pin transmitter for the production of any sound, then it would appear, on reading the amended specification, that Berliner intended to transmit speech by a composite operation of weakenings of the normal current, and breaks of the current. That breaks were to occur in the operation appears from other portions of the amended specification, thus:

"The operation of my invention is as follows: If a current of electricity of ordinary strength is made to pass through the plate and the screw across the point of contact, . . . the whole amount of electricity will not be able to pass quietly over the narrow point of contact, and the consequence will be that it will accumulate to a state of tension on both sides of the contact, and the passing over of the current at the point of contact will be so violent as to shake the plate off from the screw. The shock will be particularly strong at the setting in and at a sudden ceasing of the current, and a cracking sound will be heard from the plate, but a weakening of said current alone can also be observed by making for example a connection within the same current by a wire and the blade of a knife. When scraping the wire end over a blade of the knife, this scraping is distinctly audible on the plate. Here the current is never entirely interrupted, yet the minute variations and cavities on the plate caused by the structure of the steel and which again cause minute alterations in the intensity of the current are sufficient to shake or vibrate the plate with varying intensity, thus rendering again the same peculiar scraping noise."

This is followed by the language which we have above quoted from the specification, pages 22, 23, *supra*. The language here employed, and the figure by which it is illustrated, have primary reference to a receiver and not to the transmitter; and this supports the contention of the defendants that the principal invention which Berliner sought to cover was the receiver. If, however, this language is applicable also to the transmitter, and if the passing of the current at the point of contact would be so violent as to shake the plate off from the screw, it is apparent that a true copy of the sound waves could not be made upon the line. This would account for the failure of the single-pin instrument as a speech transmitter, and show why Berliner had recourse to the double-pin instrument.

The absence of any specific amendment stating that Berliner contemplated speech transmission with the single-pin instrument, is a strong indication that he did not intend on August 8th that his amended application should be construed as for a speech transmitter. It is apparent that the apparatus with the double-pin completely embodies the single-pin instrument. Berliner has stated in his original application all that he could accomplish with this apparatus. He also testifies to his failure with it. When he strikes this out, he strikes out all claim for the transmission of speech.

Further amendments were made on Sept. 8 and 14, 1877. That of Sept. 8 added a carbon contact, afterward cancelled. But after these amendments the application still described in the original language the composite operation of weakenings and breaks. As Berliner's novelty is said not to reside in the apparatus but in the mode of operation, this is the vital point. It is of little consequence that the apparatus is shown, if it is not shown operating in the manner described in the patent. The rewritten specification of October, 1877, still preserves a description of the composite mode of operation, with a new claim for the single-pin instrument operating "by either altering or disconnecting said contact at each vibration."

Constant contact of electrodes is first definitely claimed and described in the rewritten application of Sept. 1, 1880. At that date the invention had been in public use for more than two years, as is conceded. I am of the opinion, therefore, that the defendants have established their second defence. Berliner's June 4, 1877, application did not describe the invention of the patent in suit and was never legally amended to do so. Assuming, however, that by the August amendment the application became sufficient to support the patent, and that such amendment might be made under proper circumstances, we have still to consider the validity of the grounds upon which the complainant claims the right to amend.

There can be no doubt that Berliner had the right to drop out any one of the inventions contained in an application whereby he sought to patent several inventions. That Berliner had the right to drop out claim 4 for the double-pin instrument, and also such parts of the specification as related solely to that instrument, is clear. The question is whether Berliner had also the right to drop out portions of the text which relate solely to apparatus which he retains in the specification, and thereby change or enlarge what remained. The plaintiff's brief says, "His amendments simply withdrew from the specification *another invention* which had proved practically useless, and incidentally cancelled statements in the description of that invention, etc." This is wrong. Inspection of the document disproves it. There is quoted by counsel, also, the letter of Commissioner Simonds to the Secretary of the Interior, dated Dec. 13, 1892:

"These words describe and claim something which is separable from the main part of the instrument, an addition to what was shown in Berliner's caveat, and they embody an erroneous conception of the natural action involved. The tyro in electricity knows that now."

Referring to the amendment of Aug. 8, 1877, which struck out the passage in question, the Commissioner is quoted as saying:

"In making that change Berliner had done two things. He had cancelled the description of an unnecessary adjunct. . . . He had cancelled an erroneous statement of the natural mode of action involved."

This supports the view that the application was not for the invention of the patent in suit, but stated a wrong and impracticable mode of operation. The Commissioner is obviously wrong, however, in stating that "these words describe something which is separable from the main part of the instrument"—"an unnecessary adjunct." This is a main part of the instrument, and of the description of the single-pin instrument. It is erroneous to state, as counsel do, that the words are "words of the specification that describe the double-pin instrument." The entire passage upon which the defendants rely relates solely to a statement of the incapacity of the single-pin instruments, and of the reasons therefor. Following this is a distinct description of the double-pin instrument, and there is no confusion between the two. It is separable from the rest of the document by cutting it out bodily, but in no other way. It is not separable as dealing with a distinct subject. The Commissioner was also manifestly in error in justifying the amendment by the rule "an inventor is not called upon to state and explain the prin-

ciples of nature involved in the operation of his invention; and, if he does undertake to state them and thus misstates them, the error is not material;" and, "if the inventor undertakes to state the theory upon which his instrument operates and mistakes it, that fact is immaterial."

If an inventor states that he has invented a new machine that works, and theorizes erroneously as to why it works, he may strike out his theory and stand on his fact; and, in construing his document, we may ignore his theory as surplusage and rely upon other parts of the document. But when this inventor states as a fact that he has found that the instrument will not work, and gives an erroneous theory to explain why, when he strikes out his theory he has no fact to stand on. He has not made the instrument operative by discarding his notions as to the reason for the fact that it is inoperative. Strike out Berliner's theory, and his reasons for the inoperativeness of the invention, and there still remains his statement that "these simple instruments will reproduce any musical sound uttered in the neighborhood of either of them, but for the reproduction of special sound, such as speech, they are not adapted;" and these words can be rejected and amended, if at all, on one ground only,—mistake in writing them,—upon clear proof that this was not intended. As a statement of fact they still remain. *Jackson* v. *Brass Co.*, 72 Fed. Rep. 271.

They cannot be rejected on the ground that they relate to the double-pin instrument and not to the single-pin instrument, since inspection shows that it is not so. They cannot be rejected as theory, for there are statements of fact that remain after eliminating all theory. They cannot be rejected as an erroneous judgment as to the capacity of the machine, for the machine was old; and if Berliner had not learned its capacity to transmit speech he had made no advance upon Reis, and was not an inventor. If the amendment of Aug. 8 made the application good, it was by enlargement of the description of the capacity of the single-pin instrument by cutting off the express limitation that it was only for musical sounds, and thereby converting the application for a musical transmitter into an application for a speech transmitter. I think that it did not have this effect; but, assuming that the complainant's construction of the amended application is correct, it is manifest that the grounds, so far stated to justify the amendment, are untenable.

Counsel say, also, "Suppose it were possible that Mr. Berliner, when he filed the specification of June, 1877, thought that there was or might be some value in the breaking of the contacts in giving that louder, though harsh, sound, can it be contended that he cannot drop that error out when he discovered the contrary?" But this is inconsistent with the claim that Berliner's invention was a new mode of operation. So long as Berliner intended to make use of the breaks in the current, he had not invented a constant-contact speech transmitter. Until he had learned that speech could not be transmitted by a structure in which the two electrodes are not normally constantly in contact, he was following Reis; and, as the Supreme Court has said, to follow Reis is to fail.

An erroneous judgment as to the practicability of the composite operation of weakenings and makes-and-breaks described in the specification could not be amended as "mistake" or "error." *Manufacturing Co.* v. *Ladd*, 102 U. S. 408-411. Even should we be of opinion that rules of law permitted the amendments in question provided Berliner had, in fact, made the invention, we should still be obliged to find, as a matter of fact, to support this case, that Berliner was mistaken not as to the capacity of his instrument but merely as to the phrases employed in the application.

We therefore consider as the next question: Was Berliner's denial of the operativeness of the single-pin instruments contained in the application of June 4, 1877, a mistake of a scrivener? An examination of this question involves also the substantial question: Had Berliner, as a matter of fact, invented a constant-contact speech transmitter before June 4, 1877? The burden of proof on the question of mistake is upon the complainant. There rests upon the complainant the burden of overcoming the strong presumption arising from the terms of a written instrument. "If the proofs are doubtful and unsatisfactory; if there is a failure to overcome this presumption by testimony entirely plain and convincing beyond reasonable controversy, the writing will be held to express correctly the intention of the parties. A judgment of the court, a deliberate deed or writing, are of too much solemnity to be brushed away by loose and inconclusive evidence." *Howland* v. *Blake*, 97 U. S. 624-626; *Insurance Co.* v. *Nelson* 103 U. S. 544; *Coyle* v. *Davis*, 116 U. S. 108; *Cadman* v. *Peter*, 118 U. S. 73; *Moore* v. *Crawford*, 130 U. S. 122. The doctrine of these cases is fully applicable here.

A reading of the original application affords no evidence of mistake. The application does not disclose the fact that Berliner had made the invention of the patent in suit, nor that he intended to apply for it; it contains no evidence that Berliner had discovered that speech could be transmitted with the single-pin instrument. The document discloses no evidence of an intention of Berliner to include in it the single-pin instrument as a speech transmitter. I adopt the statement of counsel for defendant: "It is impossible to read the specification, with its perfectly lucid and orderly description of three specific inventions, following upon three caveats in which they were described in Berliner's own words, and not perceive that that is all he wanted to describe in his application,"—excepting, of course, the minor inventions of diaphragms. If this document be read with Berliner's denial of an intention to claim his single-pin instrument as a speech transmitter retained, it is perfectly clear and consistent, showing that he intended to cover a variable-pressure receiver, a sparking and recording receiver, a make-and-break double-pin speech transmitter, a concavo-convex diaphragm, a perforated diaphragm, and the two single-pin instruments for the transmission of sounds other than speech; or we may interpret it as proving an intention to claim the single-pin instrument as a musical transmitter.

On the contrary, if we read it according to the complainant's contention that it was intended to cover a single-pin speech transmitter, the whole document is thrown into inconsistency and confusion. It is obvious that the statements concerning the single-pin instrument and its capacity are such as could have come only from Berliner himself. No scrivener would have volunteered such statements. No scrivener would have volunteered such reasons in support of the statements, nor illustrated them by references to drawings. The alleged mistake does not relate to a matter of form. The statement is of the substance. If there was mistake, it was in the erroneous opinion held by Berliner, and not in any expression of his beliefs or opinions. The word "error" is used by counsel in a double sense to signify, first, a mistake in expression; second, a mistaken belief. There are two distinct contentions, which should not be confused. We will consider later the contention that Berliner had made the invention of the speech transmitter of his patent, even though he believed on June 4, 1877, that his single-pin instrument could not transmit speech.

There is no express reference to the capabilities of the single-pin instrument as a speech transmitter, although, had he made the invention, Berliner could not have failed to state first and principally what he had accomplished with this instrument in the transmission of speech. Had his invention been made, had the adequacy of this means been proved, it is highly improbable that he would have made a claim for the double-pin instrument and a mode of operation which was a reversion to the theory of Reis; or, at least, was intermediate between the constant-contact method of Bell and the current-breaking of Reis. Berliner testifies that the two inventions of the "variable-contact transmitter" (as he terms it) and the contact receiver, consisting essentially of a diaphragm in electrical contact with a pin or screw, were meant to be covered by claims 1, 2 and 3 of the said application. I am of the opinion, however, that claims 1 and 2 were not intended to describe a transmitter, but merely a receiver; and that claim 3 was merely for two instruments for the transmission of sounds other than speech. It is to be observed that the force which actuates the transmitter is the force of the sound-waves; yet claims 1 and 2 contain the clause "and capable of being put in vibration by the action of the electrical current substantially as set forth." This is a characteristic wholly unnecessary to be mentioned in describing a transmitter.

Professor White, however, testifies that the mechanical conditions under which each instrument best performs its functions are also very different; "that, if we have a Berliner transmitter with steel points in circuit with a Berliner receiver also with steel points, and adjust the two instruments with care for the best performance of their respective functions, speech is readily transmitted and understood. If, now, without changing the adjustments of either instrument, we speak into the receiver, thus making it a transmitter, and listen at the former transmitter, thus using it now as a receiver, it is found that speech cannot be successfully transmitted and received. Sound is heard, but crude and harsh, with much breaking, and scarcely anything can possibly be understood. These experiments show in the most convincing way that the operations of the forces of the two instruments are by no means identical, on the other hand, are radically different; and that the mechanical conditions under which each best performs its functions are also very different." It thus appears that the words "capable of being put in vibration by the action of the electrical current" imply an adjustment that would practically incapacitate the instrument as a speech transmitter.

The learned counsel for the defendants have made a summary of the contents of the application which so completely covers that document as to negative any reasonable belief that Berliner's solicitor was mistaken in its preparation. There is no evidence that, in the description of the other inventions, the solicitor failed to express Berliner's meaning. The descriptions follow the caveats perfectly, and the claims follow the descriptions perfectly, except as to the transmitter of the caveat of April 14, 1877. Omitting that, the description and the claims are clear, complete and exact. The internal evidence of the application is all against the complainant.

Berliner testifies as to the preparation of the application, saying that he had made several distinct inventions and sought to save money by putting them into one application; that he had made one invention described in a caveat of March 29, 1877, for a system of magneto-telephony, which he did not believe valuable enough to include in the specification; that he intended to insert, "first and principally, the invention consisting of a diaphragm in electrical contact with an opposite pin, by means of which I could send undulatory currents of electricity corresponding to sound-waves by decreasing and increasing the pressure between said diaphragm and said contact pin. This is described in the caveat filed by me April 14, 1877." This statement must be read with great caution. It was made in 1893, sixteen years after the event; after continuous controversy in the patent office, and when he is to be considered as an expert. His language is to be given no liberality of construction. If statements of intention made under these circumstances can be of any force as against a written statement under oath, to the contrary, yet this statement is insufficient on the ground that it does not meet the point. It is obvious from the specification itself that Berliner did intend to include the single-pin instrument and to employ "weakenings" as a part of his composite method for the transmission of musical sound. The inquiry is not as to whether Berliner intended to send undulatory currents, but whether he intended

to send undulatory currents of the form requisite for speech by the single-pin instrument. In the argument for the Bell Telephone Co., 126 U. S. 299-309, Mr. Storrow, interpreting the Bell patent, clearly pointed out that speech is not a necessary result of an undulatory current; that undulatory currents may be used for musical transmission and other purposes. Berliner's evidence does not prove an intention to claim the single-pin instrument operating throughout its entire range of movement without break, to produce an undulatory current of the form requisite for speech. Before the Board of Appeal, counsel for Berliner argued, "Can it be discovered from any part of the (specification) that the inventor meant to employ variable pressure as an element? For if he meant to employ it at all, that is enough." Counsel also refer to "variable-pressure periods of transmission" with intermediate breaks. Berliner's testimony may mean only that he intended to send undulatory currents in periods between his intended breaks, or that he intended to send some undulatory currents having "nothing of the nature of each wave and the shape of their curves."

The argumentative character of Berliner's testimony will be observed upon reading it. It is entirely reasonable to suppose that Berliner, when he gave this testimony, was of opinion that he did intend to employ undulatory periods as a part of his method of operation in connection with the makes and breaks; and that he reasoned that, as he intended to employ these, he intended his instrument for the production of an undulatory current and was entitled, therefore, to credit for the general invention of an undulatory current transmitter which would include speech transmission, though he had not accomplished it. Though this is erroneous reasoning, it was and is the reasoning of counsel and may fairly be attributed to Berliner.

Testimony as to an intention existing sixteen years before is of very slight weight at best, even when in direct and positive form; but when it may be based upon an "interpretation" and is equivocal in expression, it can have no force against a sworn statement in writing.

It is claimed that mistake arose from speedy preparation by an incompetent solicitor's clerk, and because this clerk had difficulty in understanding Berliner (who was a foreigner) on account of his imperfect accent. The charge that this statement appears in the specification through any fault of this clerk I believe to be unjust and untrue. It is certainly not proven. Berliner applied to a solicitor on May 13, 1877. His application was sworn to on June 2, 1877, and filed on June 4, 1877. He was turned over to Coombs, a clerk. Berliner says, "He made copious notes, and I remember giving him a few notes of mine." Coombs, the clerk who wrote the application, stated that he got explanations from Mr. Berliner previous to finishing the rough draft of the specifications; that they had an imperfect model or instrument, helped out with rough sketches and explanations; that at the time of drawing the specifications he had a general knowledge of electricity, but very little knowledge of speaking telephones; that Mr. Berliner's telephone was the first one he had ever seen or handled; that he found it rather difficult to understand Mr. Berliner on account of his imperfect pronunciation, and further "because the subject was strange to me."

The testimony as to the actual fact of mistake is remarkably meagre. Nor is it clear as to the amount of time spent in preparing the specification. Berliner testifies to a hurried examination of the rough draft of the specification, but that he did not read the final draft. That there was a mistake, we have no other evidence than the vague statement of Berliner. Coombs testifies to no mistake. There is evidence that Coombs was furnished with notes and explanations. No evidence is offered as to what those notes were, nor as to when they had been prepared. Berliner himself was not uneducated, but a man of intelligence and of unusual skill and facility in the use of language, and fully competent to have prepared complete instructions to Coombs. He had formerly written caveats by his own hand, viz., one of March 29, 1877, one of April 14, one of April 30, and one of May 9. In the summer or fall of 1877, he himself drew an application for patent No. 199,141, which is in perfectly good form, and conducted all the proceedings himself. The evidence as to speed in preparation of the application by a solicitor ignorant of the subject is evidence of the completeness of the instructions given by Berliner to Coombs. There is no evidence as to whether the caveats or copies were in the hands of the solicitor; but the application follows closely those caveats, and shows no error of Coombs in respect to any other invention. In fact, the only direct evidence of mistake is Berliner's own testimony.

Berliner does not testify that he instructed or informed Coombs that he had found that this instrument was capable of transmitting speech; nor does Coombs testify that there was any information offered to him as to the capabilities of the single-pin instrument for speech transmission. It certainly has not been made to appear that any mistake was made by Coombs in transcribing or putting into form any fact or statement communicated to him by Berliner. Coombs did his work thoroughly and accurately as to other inventions; presumably he did so as to this.

Berliner does not testify that he gave to his solicitor any documents inconsistent with the specification as filed. He does not state that any specific phrase in the document differs from what was stated by him to the solicitor. He does not state that he did not himself write or authorize the passage in question. He does not state that it was his intention to describe in his application a speech transmitter competent for the production of sounds without make and break. He is not called upon to deny categorically that any specific statement made in the specification was authorized by him. It was the duty of the complainant to prove in detail, and to the best of its ability, just what the mistake was, and how it occurred. Counsel say merely, Berliner was a German, his solicitor was incompetent, and application was hastily drawn and hastily read. They do not prove what the mistake was. They do not prove that Berliner did not fully authorize the statement that the instruments were not adapted to transmit speech. Expert interpretation is no substitute for testimony as to facts.

The oath of Berliner to his application completely overcomes his vague and uncorroborated oral evidence as to the actual fact of mistake. It would be contrary to the rules of law to allow a sworn statement to be swept aside by incomplete, loose and inconclusive evidence of this character offered by the party whose duty it was to produce all procurable evidence on this point. Berliner, however, has not only the burden of proving that mistake was made, but also the burden of accounting for his failure to discover it. If mistake was made it was on June 2. It was not discovered until August. We find, however, in the conduct of Berliner immediately after the filing of the application, evidence that this was no mistake. On June 27, more than three weeks after the filing of the application, an amendment was made relating to the double-pin circuit-breaker. On July 14 another amendment was made relative to the double-pin instrument and to the air discharge instrument; and on Aug. 8, 1877, the double-pin instrument was stricken out. From June 4 to Aug. 8 there stood on the files in the Patent Office a complete denial of the invention now claimed, and Berliner was examining and amending his specification in relation to the double-pin instrument, and during this period failed to discover any mistake. He attempts to account for this, saying that he had a badly copied letter-press copy of his specifications, "but in the course of time I would now and then, by fits and starts, pick up this letter-press copy, open its pages in a haphazard fashion, and then I would read passages of the specification in a manner. I would discover parts of passages which did not seem to sufficiently express all I meant to say and all I thought I had communicated to Mr. Coombs. After discovering such deficiencies, I would go to Mr. Norris's office and ask that the objectionable parts be amended or that additions be made, which was done by Mr. Norris. At another time this would be repeated. I would come across another passage which I thought needed amending, and I would again go to Mr. Norris to have it amended; and in that way the number of amendments referred to is accounted for." Not one of the amendments made by Mr. Norris up to Aug. 8 bears this out. The first amendment of June 27, 1877, contains no corrections, but an additional description of his make-and-break double-pin instrument, and a new claim for the bent spring. The second amendment of July 14 substitutes the terms "spring made of metal" for the words "steel spring;" and there is contained an additional statement, not a correction, in reference to the air discharge instrument. On July 27, 1877, is another addition, and not a correction, concerning the air discharge instrument. No one of these actual amendments corroborates the testimony of Berliner that he discovered objectionable matter in the expressions of Coombs, and therefore made amendments.

These amendments, on the contrary, contradict his testimony. It is entirely improbable that these passages in the original draft could have escaped the attention of a man so skilful in the use of the English language, and so intelligent as Berliner; that he could have examined the document for the purpose of making the specific additions that he did make, and that he could have overlooked the denial of the very essence of the invention which he claims. If there is any degree of probability in this statement, the preponderance of probability is so strong against it that this evidence must be rejected upon the ground of its weak and inconclusive character upon the issue of mistake. He testifies that his first discovery of the error of the section dealing with the secondary pin, double make-and-break operation was in the early part of August, 1877; that, happening to pick up the copy of the specification, he immediately noticed "that Mr. Coombs had mixed the matter up considerably, and that the passages referred to did not express what I had invented; and, in fact, misrepresented it. At first, I thought I would amend this part of the specification so as to make it read right and convey the correct meaning such as I had laid it down myself in the caveat of May 9, 1877." He then testifies that he had by that time concluded that the double contact make-and-break instrument did not amount to much, and resolved to strike out the whole matter relating to it. It is apparent, however, that even then, when he learned of this vital error, he did not change the conception of the single-pin instrument operating as a transmitter by make and break, for his amendment of Aug. 8 still left the statement that the break or weakening of the electrical current was the method of transmitting sound.

Prior to any amendment in which, by any liberality of construction, we can find a constant-contact speech transmitter, there appeared the Philadelphia *Press* article, and Edison filed his application of July 20, 1877, for patent No. 474,231.

Assuming, however, that Berliner's testimony is to be interpreted as meaning that he did intend to describe and claim the single-pin instrument as a speech transmitter, it can have no force against his written statement unless corroborated by other evidence. Unfortunately for the complainant the only evidence in this case as to any success in experiments comes from Berliner himself. The two other witnesses produced to testify on this subject both say that at the experiments attended by them no speech was transmitted. Berliner testifies, however, to the presence of several other witnesses at other experiments, but the witnesses are not produced or accounted for. The testimony of these two witnesses is corroborative of the statement, made in the application,

that the simple instruments were not adapted to the transmission of speech; and the non-production of the other witnesses is a strong fact against the complainant.

We will consider, however, the contention of the complainant that, as a matter of fact, Berliner had made the invention before June 4, 1877. What did Berliner accomplish in speech transmission prior to June 4, 1877? He testified that he procured a copy of Bell's patent of March 7, 1876. "I studied his patent over and over again, and it became deeply impressed on my mind." A statement of the history of his invention was made by Berliner in Telephone Interferences, and was sworn to on April 12, 1879. In this he says that he commenced experiments in January, 1877. Being in a telegraph office, an operator explained to him the importance of pressing down the Morse key firmly in order to insure the prompt operation of the sounder; that it then occurred to him that, if a variation of contact pressure between the circuit-closing key and its rest could produce a variation in the current, then a varying pressure between the points of contact could be obtained by the vibration of one or both of them imparted to them by sound or sound-waves in the air in their neighborhood; that he constructed apparatus and proved by a galvanometer that changes of the current could be produced. He stated also that he made experiments on March 4, 1877; and that "a person at the receiver heard sounds when I spoke against the diaphragm of the transmitting apparatus, but could not generally make out the words I spoke;" also that, on April 12, 1877, using apparatus consisting of two single-pin instruments, "upon singing against the diaphragm of one of the instruments, the tunes could be heard distinctly at the other; and in speaking my voice would be recognized, and the persons listening said they understood what I said." He does not, in this document, state that he himself heard the instrument transmit a word.

In 1893, fourteen years later, Berliner testified in the case brought by the Government for the cancellation of the patent, and gave the names of the persons present at the experiment of March 4, 1877,—Simon and Gustave Oppenheimer. Simon Oppenheimer testified concerning this experiment, saying:

"Berliner and my brother went upstairs, and I remained on the lower floor, and he first whistled into the instrument and I heard that,—heard his whistling; and then he sang, and after trying that several times he tried talking. I could distinguish one from the other,—change of voice, but I could not make out any words."

Whether the witness means change in Berliner's voice, or change of voice from Berliner to his brother, is not clear. The other person present has not been produced or accounted for. The evidence of Oppenheimer throws light on the meaning of Berliner, when he says in his preliminary statement that a person could not generally make out the words that he spoke. Taking these statements together, the proof is that no words were heard on March 4, 1877. Berliner, in 1893, testified also to the experiment with two single-pin instruments in April, 1877, referred to in his preliminary statement. But a single experiment was made with this apparatus before the writing of the caveat of April 14, 1877. The preliminary statement and Berliner's evidence refer to this experiment, though in the preliminary statement the date is given as April 12, while in the oral evidence it is given as April 11. The second single-pin instrument was first constructed on the 10th of April. He says:

"On the next morning before going to the store, I tried a practical experiment from my room to the room downstairs, and made the ladies of the house listen. They were very greatly surprised when I transmitted, as I always did for the purpose of amusing them, by means of interrupted currents; they heard the tunes loudly all over the room, and when I made them listen close to the apparatus and transmitted by variation of pressure, they reported to me much better results that they had previously heard at other experiments, and they also thought that it was very wonderful indeed. They recognized and got familiar sentences now and then. It was very difficult to adjust the apparatus. I had to run upstairs and downstairs continuously, both for adjusting the transmitter and the receiver. The current would heat the contact, the plate would bulge off a little and get out of adjustment; but we did get quite good results. I immediately prepared, on the evening of the same day, a caveat describing what I did. I made a clean copy of my rough draft on the 12th, swore to it on the 13th, and filed it on the 14th."

He testifies, also, to a practical experiment, the date of which is not given:

"My listeners reported to me that when accidentally, as it happened very often in these experiments, the current was interrupted, they heard that familiar buzzing—the familiar musical sound they had heard before; that between such sounds, however, they heard a very faint sound, which they recognized as my voice, and that occasionally they thought they understood familiar words or sentences. I then went downstairs to listen for myself, and I found the same result when some one was speaking or singing upstairs."

He testifies that:

"I then for the first time noted the very great difference in the character of the sound emanating from the reproducer. The quality of the sound when the current did not interrupt at the transmitter was that pure, human quality, sounding perfectly natural though very far off; but it was entirely different from the buzzing musical sound that had no admixture whatever of the quality of a human voice when the current was interrupted. I now and then thought I could make out the words of familiar sentences, but it was exceedingly faint."

He gives the names of persons who had listened at the instruments, namely, "Mrs. Gangewer, the lady I lived with; her daughter, at that time Miss Emma Gangewer; her son, Mr. Harry Gangewer; my room-mate, Mr. William Pribram; and two friends of mine, Mr. Simon and Gustave Oppenheimer, brothers." With the exception of Simon Oppenheimer, not one of these witnesses is produced, nor is the failure to produce these witnesses accounted for. A single other witness—Adolphus S. Solomons—testified that "I heard sounds which appeared to come from a violin; I felt sure I heard a violin playing." From his evidence it is apparent that Berliner endeavored to speak through his instruments; but the witness testifies that he told Berliner that he heard no speech, only some sort of a noise. The entire case as to experimental results in speech transmission rests upon the unsupported testimony of Berliner. As counsel says, there are occasions in the world when the paucity of proof in the affirmative is positive proof in the negative. Considering the great importance of establishing by other witnesses experimental results inconsistent with Berliner's express denial in his application, and the entire lack of any explanation of the absence of several witnesses who could testify upon this issue the presumption is justified that the testimony of these witnesses would be unfavorable to the complainant.

If a party has it peculiarly within his power to produce witnesses whose testimony would elucidate the transaction, the fact that he does not do it creates the presumption that the testimony, if produced, would be unfavorable. *Graves* v. *United States* 150 U. S. 118; *Runkle* v. *Burnham*, 153 U. S. 216-225; *Clifton* v. *United States*, 4 How. 242.

We should also consider the inherent dangers of oral proofs, when a witness undertakes to disprove former statements made by him in writing. In addition to this, the principles stated in *Barbed Wire Patent*, 143 U. S. 275, 284, 285, seem to be applicable to the testimony of Berliner, in view of the fact that his amendments were made after Edison's invention of a constant-contact speech transmitter, and after the Philadelphia *Press* article and the applications by Edison. Upon the whole evidence, I am of the opinion that, according to the strong preponderance of proofs, no one of Berliner's instruments ever transmitted a word of human speech under his manipulation; and that the only results that he ever got were such as are described in the application and attributed to the double-pin instrument. Professor Brackett testifies: "I have no doubt that, if he endeavored to transmit speech with the single-pin instrument of the application, which he refers to in the expression 'these simple instruments,' he found that they were not adapted for the transmission and reproduction of special sounds to be a fact. In this, his experience would not differ from that of every one who has attempted to transmit speech with the Reis and Regnault apparatus, which as apparatus is identical in principle and organization with that of the application." This was the fact with Edison, who rejected as useless what Berliner by his application rejected as useless. That a feat of experts has made that apparatus talk proves nothing as to Berliner.

The documentary evidence upon this point, to and including June 4, 1877, is the caveat of April 14, 1877; the caveat of April 30, 1877; the caveat of May 9, 1877; the application of June 4, 1877. The latter is by its character most important, being his latest statement of what he had done at the date of his application. This proves that he had not secured speech with the single-pin instruments; that he was seeking to secure speech by make and break of contact. It shows that he thought that, by this method, with a double-pin instrument he had succeeded in reproducing "a great many special sounds, such as the vowels and others." The application overcomes the evidence as to experiment. Moreover, the fact that he was beyond all question attempting to get speech with a broken current renders it highly probable that he had not got it otherwise.

We will next consider the bearing of evidence as to the capacity of Berliner's instruments. It is proven in this record that Berliner's instruments, under proper conditions and manipulation and when properly adjusted, are capable of transmitting speech. It may be said that it is highly probable, if instruments constructed by Berliner will transmit speech, that he succeeded in doing so. This argument was presented to the Supreme Court concerning the instruments of Reis, 126 U. S. 193. It was there argued that to admit that the Reis instrument will speak now, and at the same time to deny that, with all his efforts to that end, the inventor made it speak in his time, had only boldness to commend it; nevertheless, the Supreme Court rejected this argument, found that he had not, and said, "The question is not whether the apparatus devised by Reis to give effect to his theory can be made, with our present knowledge, to transmit speech; but whether Reis had in his time found out the way of using it successfully for that purpose." *Telephone Cases*, 126 U. S. 539; *United Telephone Co.* v. *Harrison*, 20 Eng. Rul. Cases, 601. It is curious that the Reis apparatus should be asserted both against Bell and Edison upon the testimony of experts as to its capacity. The present question is not as to the operativeness of the machine. It is a question of Berliner's knowledge; of discovery. The burden is upon the complainant, if it relies upon the present capacity of the instrument as proof of Berliner's knowledge; of his discovery and of mistake, to show, not its present capacity in the hands of experts, but its capacity under the exact conditions under which Berliner was working.

Expert experimentation has disclosed the fact that the ordinary Morse key, the Reis transmitter, French nails and Berliner's instrument can be made to transmit speech under proper conditions and manipulation, but we cannot accept this evidence upon the issue of mistake for it is not proved that the experiments were conducted under similar conditions. It is a familiar rule of law that experiments, to be of value as evidence on such an issue, must have been made under circumstances similar to those constituting the premises from which the original event is alleged to have been the conclusion. 12 Am. & Eng. Enc. of Law., 2d. Ed. Vol. 406; *Hawks* v. *Charlemont*, 110 Mass. 110; *Commonwealth* v. *Piper*, 120 Mass, 185; *Edit.* v. *Cutter*, 127 Mass. 522; *United Telephone Co.* v. *Harrison*, 20 Eng. Rul. Cases, 601.

The danger of this kind of evidence is apparent if we apply it to the double-pin instrument. Berliner was unable, according to his oral evidence as well as his statement in the application, to get

speech with a double-pin instrument. Experts have succeeded in doing so, and Professor Wright testifies that, properly adjusted, the second pin "somewhat extends the range of voice intensity for which the instrument can be used;" but this does not disprove Berliner's testimony as to his failure with a double-pin instrument. In like manner, the success of experts with the single-pin instrument does not disprove the statement made by Berliner in his application.

The complainant, if it desired this evidence to be accepted as evidence of mistake or of Berliner's knowledge, should have proved and called to the Court's attention proof of the exact conditions existing at Berliner's experiments; it should then have proved that similar conditions were created in the experiments of experts, and that then the result accorded with Berliner's testimony. Anything short of this is not competent legal evidence to sustain the burden of proof as to mistake, though it might be were the issue merely as to operativeness. The question is not as to the capacity of the instrument, but of its actual performance at a certain time. Berliner's experiments in speech transmission with an instrument having an iron diaphragm were conducted hastily on the morning of April 11, before he went to the store. It is in evidence that he was accustomed to go to the store at half-past seven in the morning. For the first time he had coupled together two single-pin instruments; and this experiment was the first exhibition of his new receiver. He was embarrassed not only by the difficulties of adjusting his transmitter, but with the difficulties of adjusting for the first time his new receiver.

It is to be noticed that there is no evidence of results between April 14 and June 4, 1877. In determining the probability of successful results in speech transmission at this experiment, we should consider also the circumstances immediately preceding the filing of the caveat of April 14, which clearly show that it was based principally upon what he considered a new phenomenon. On the 8th of April occurred a dramatic and impressive incident, in consequence of which Berliner states, "I became much agitated." On the 8th of April, six days before filing the caveat, late in the evening, he had connected the instrument to the galvanometer, and was connecting two terminal wires for the purpose of closing the circuit.

"It was exceedingly quiet about the house and on the street. In closing the circuit I suddenly heard **a noise coming from the diaphragm**, which surprised me very greatly. I thought I had mistaken my ears, but on repeatedly making and breaking the circuit, a distinct and sometimes loud tick came from the diaphragm and apparently from the point of contact between the diaphragm and the steel ball. That was entirely new to me, and I became much agitated, because I saw immediately that I had here a new acoustic phenomenon, viz.: that sound was produced **without the aid of electrical magnetism**, merely by the current itself. I quickly took the tuning-fork which I had in my possession; I wound one of the wire terminals around the shank of the tuning-fork, struck the same on the table, and applied the vibrating prongs to the other terminals of the line. Immediately a loud musical sound corresponding in pitch to the sound of the tuning-fork came from the iron diaphragm. I knew at that moment that I had made an important addition to my observations, for I quickly perceived **that if the diaphragm could give out a musical sound** it could also reproduce speech when, instead of an interrupted current, an undulatory one was sent to affect it."

This was the first conception of his receiver—a new and distinct invention by which, using the language of his application of June 4, he could effect the object of producing by a common galvanic current "marked mechanical effects that will be distinctly demonstrated to the observer." Here, then, was a new invention; one not exhibited before, and which was first exhibited to others on the eleventh day of April. From that time he experimented only with his new receiver in connection with his transmitter.

It is in evidence that the adjustment of the transmitter and receiver is quite different.

In the experiments made by the experts it appears that the adjustments were delicate. It further appears that, for the successful transmission of speech, there is a very narrow range in the movements of the electrodes.

Professor Wright has testified that, "When transmitting speech, the electrodes of the microphonic transmitter are brought together with a pressure which is very light, and which has been determined by experiments to vary within a comparatively narrow range." The evidence shows clearly Berliner's readiness in applying for caveats upon hasty experimentation. His caveat of April 14, for the two instruments coupled together, was based upon a single experiment in which his attention was in all probability chiefly engaged in exhibiting the marked mechanical effects that he had discovered how to produce by his new receiver, and which seem to have been the chief incentive to the filing of the application of June 4. The evidence accords with the views of the defendants' counsel, that claims 1 and 2 of the original application were merely for a receiver.

The complainant contends that Berliner's invention did not reside in structure; that he reproduced substantially the old Reis apparatus, which can be operated either to break the current or to preserve it unbroken. His invention is said to be a new mode of operation. Proof that he reproduced the old apparatus does not prove that he discovered the practicability of a new mode of operation. He is not entitled as an inventor of apparatus to claim whatever may be found to be within its capacity, because his sole claim to invention is based upon an alleged discovery of a new capacity in old apparatus. If he did not discover this, nothing new remains that he did invent or discover. He did not "embody" an invention in a machine until he succeeded in making the machine perform Bell's process upon the current. He no more made the invention by making the machine than did Reis or Morse.

Upon the question of mistake and of the right to amend, we have, finally, Berliner's caveat of April 14, 1877. This document is the chief reliance of the complainant. It may be said that it is practically the complainant's case. It is presented as evidence of mistake in the application; the argument as to the right to amend is based chiefly upon it; it is also contended that it counts as a full reduction to practice. We have to consider two distinct contentions; first, that it is evidence that the application stated what Berliner did not intend to state—a question of mistake; second, that by writing this caveat Berliner had completed and reduced to practice the invention of a speech transmitter "even if he had not known that he could transmit speech, or even if he had believed that he could not." This remarkable contention raises a question as to the effect of erroneous opinion, rather than a question of mistake. If Berliner was an inventor of a single-pin speech transmitter in spite of his belief on June 4, 1877, to the contrary, this would not have prevented him from making the statement that his instrument could not transmit speech, nor would this aid the complainant in showing that he intended to apply for a constant-contact speech transmitter. An invention which the applicant had not intended to include could not be introduced by amendment upon a change of intention.

Is the caveat inconsistent with the statement in the application upon a comparison of the two documents? The earlier, from its nature, "does not purport to be an account of a result accomplished, but of a result expected and desired." Robinson on Patents, Section 448. The latter purports to be a description of a completed invention, the expression of the matured and final opinion of the inventor. This caveat proves that on April 14, 1877, Berliner intended to use the instrument of the patent to alternately weaken and strengthen the current. The patent in suit follows closely the language of this caveat, though it differs in essential particulars. We may assume that it proves intention, and a project existing on April 14, 1877. The existence of this intention on April 14 is some evidence of the existence of a like intention on June 4. As a matter of fact, however, the document is not conclusive upon the question of constant contact of electrodes. "It does not state that the transmission of the electric force is to be made through a closed circuit, although this . . . is really the principle on which a successful working invention depends." See *United Telephone Co.* v. *McLean*, 20 Eng. Rul. Cases, 587. Though it says that the current is to be strengthened and weakened, it does not expressly state that the current must not be broken, but says:

"Part 6. If the uttered sound is so strong that its vibrations will cause a breaking of the current at the point or points of contact in the transmitter, then the result at the receiving instrument will be a tone much louder, but not as distinct in regard to articulation."

The document affords no evidence of the amount of experimental basis for this statement, or whether it was based largely upon theoretical considerations. It would be obvious, perhaps, that a broken contact could not produce with the same accuracy as an unbroken contact sound-waves impressed upon the diaphragm; though it would not be so obvious that the louder and more audible effects were useless for speech transmission, and must be rejected. Had Berliner succeeded in transmitting speech by a composite operation of weakenings and breaks, that method could have been found in the caveat, which refers to a tone "much louder, though not as distinct, in regard to articulation," produced by a broken current. In the brief filed before the Commissioner on appeal from the primary examiner's rejection, it was stated by Berliner's counsel in reference to this language that "Berliner knew that any break would injure articulation, though there might, he thought, be some breaks which would not absolutely destroy it." This interpretation by Berliner's former counsel is much fairer than that of Professor Cross—"The caveat also states that under strong sounds the transmitter would break the current; but that, in so far as it broke, it would be useless for the transmission of speech." This is unwarranted. The caveat, therefore, does not prove that Berliner had learned that the breaks of contact were inadmissible, produced no articulation, and must form no part of the intended operation, and that in speech transmission he must discard his most conspicuous receiver effects; but suggests a doubt upon this subject. This doubt apparently ripened into an erroneous opinion as the result of experiments which led to the caveat of May 9, and to the double-pin instrument of the application of June 4, 1877. Whatever was his intention or opinion on April 14, the document of that date does not displace the statement in the application of June 4. They are reconcilable on the view that the caveat was the expression of a project formed after hasty experiments which showed only a few variations of current; not Bell's speaking current.

But this document does not stand alone. It is merely one of several documents; and it is the general rule that later expressions are of greater force than earlier. We must consider, in connection with the caveat, not only the application, but the other caveats of April 30, 1877, for a circuit breaker, and of May 9, for a circuit breaker. Berliner's model filed June 4 was based upon this caveat of May 9; and the application for a speech transmitter follows this caveat. Previous to June 4, then, we have as evidence of Berliner's intention and affecting the question of mistake, three documents: the first, showing an intention to use a weakening and strengthening of the current, but suggesting a doubt as to a breaking of the current, the other two showing most conclusively that between April 14 and June 4 Berliner intended to utilize a broken current. He testified also that, immediately before the preparation of his caveat of May 9, he thought that he "had a phenomena which apparently was different from Mr. Bell's conception of what an interrupted current might do, namely, since he said that an interrupted current could only produce pitch, while I had here something more than pitch, something of the combination and quality of sound." It was, of course, desirable to use an interrupted current, if possible, and thus avoid Bell's patent. The preponderance of documentary proof, as to intention on June 4, would overcome the

caveat of April 14, even if we should regard it as complete evidence of Berliner's intention on that date to preserve constant contact of electrodes. We have also, in addition to the evidence of Berliner's intention prior to June 4, proof of an intention similar to that expressed in the application existing long after that date. The amendment of Aug. 8 left the description of a composite operation of breaks and weakenings of the electrical current still remaining. The erasure, in connection with the fact that his attention had been called to the matter and that he did not change his statement, is evidence that Berliner, on Aug. 8, did not intend constant contact as his normal mode of operation.

In his oral testimony he states that he thought that he had discovered greater capacity in a broken current than Bell attributed to it. In September, 1877, he issued a circular or memorandum to his co-laborers in science, describing his single-pin instrument, saying, "Any vibration of sound striking one of the plates will either weaken or interrupt the point of contact, and thereby the current, and will thus cause the other plate to vibrate in unison with the first, reproducing the same sound." In his substitute specification, filed in the Patent Office Oct. 27, 1877, he claimed a circuit breaker; and in a subsequent patent, No. 199,141, written by himself and applied for Oct. 16, 1877, he stated, concerning his application of June 4, 1877: "The transmission was made by either breaking the contact or by alternately weakening and strengthening the same at each vibration of sound affecting the plate. The reproduction of sound was effected by permitting such a current thus consisting of electric waves to pass through a similar receiving instrument . . ."

The intention expressed in the application, therefore, existed long after Aug. 8. It is certainly more probable, also, that Berliner intended to follow the later caveat of May 9 than the earlier caveat of April 14, for the instrument of the caveat of May 9, and of the application, has all the capacity of the single-pin instrument as well as such additional capacity as results from the addition of the second pin. As evidence of Berliner's accomplishment, the caveat is of slight value. It proves what he was trying to do. It does not prove that he had by experiment secured such an adjustment of his apparatus as enabled him to secure results inconsistent with what is set forth in his application of June 4, 1877. Counsel urge that "even in the double-pin instrument (of the caveat of May 9, 1877) which did make and break, the dominating principle was after all, as far as possible, to keep the contact, and to keep it in such a way as to vary the pressure so that even if there is an intermediate break, yet it is a break which is intermediate only, and takes place, if at all, only between two variable pressure periods of transmission."

This is inconsistent with the complainants' brief, but if this be true, we have strong evidence that Berliner abandoned the intention of April 14. Berliner states in his application of June 4 what he could accomplish with the double-pin instrument: "I have thus succeeded in reproducing a great many special sounds, such as the vowels and others." If it be said that this refers to the make-and-break method, we may refer to his oral testimony: "I continued to experiment with this apparatus for a few days, but could not possibly get anything else but these three vowel sounds, and generally only two, and nothing at all of consonants."

This caveat was filed May 9. Prior to May 13 he had consulted a solicitor, and had a model made at his request which he took to his solicitor on May 13. This model embodied both his single-pin instrument and his double-pin instrument. A certified copy of this model will transmit speech in the hands of experts. Will it now be said that Berliner's failure with a double-pin instrument was because its dominating idea was to make and break? This is inconsistent with the views of counsel on final argument. The simple fact, according to all probability, is that Berliner spoke to his double-pin instrument, adjusted it the best he could in the light of all he knew as to the capacity of the single-pin instrument, and "thus succeeded in reproducing a great many special sounds, such as the vowels and others," which he attributed to the second pin.

With this apparatus he had got more than with his single-pin apparatus, probably for the reason that under expert handling, the best operation of the instrument is when the contact is so weak that breaks are likely to occur with great frequency, and render the instrument impracticable for commercial use. His first approximation to speech was when he attempted to break his current and make contact with the second pin. Berliner, therefore, after experiment, arrived at the conclusion that his single-pin instruments were incapable of transmitting speech. He formulated clear and definite reasons for this opinion. He stated these clearly to his solicitor, who expressed them clearly according to his instructions. He also told his solicitor all that he had accomplished with the double-pin instrument, a drawing was made showing this double-pin instrument, provided with a speaking tube and an ear tube, and the solicitor clearly stated all that Berliner had accomplished; this was his best result. The application of June 4 clearly represents his last opinion, and shows conclusively that he had produced no experimental results to the contrary.

Even had this caveat made the express statement, "I have succeeded in transmitting the quality of sound, and I think I have obtained some words," the sworn statement in his application would not be inconsistent with the caveat. It would simply prove the insignificance of his results. There is no difficulty nor improbability in the supposition that, after the full preparation of his caveat, Berliner still had to ask himself the question, "Will it work?" It is in accordance with all the probabilities, with the experience of Reis and of Edison, that he found that it would not.

The complainant next contends that whatever may have been Berliner's opinion as to the capacity of the instrument, and even if he thought he knew that the instrument would not transmit speech, he had yet made the invention of the patent in suit because the caveat is a complete reduction to practice. As we have already observed, this would still be insufficient; for, in order to amend, he must both have made the invention and have intended to apply for it. But, as the contention may be renewed, it may be well to consider it. The contention that the caveat of April 14, 1877, counts as a full reduction to practice, irrespective of experimental results, is equivalent to a claim that, had Berliner stated in writing simply, "Reis's instrument operated by the Bell method will transmit any and all sounds," this constituted a complete reduction to practice, even were Berliner ignorant of the truth of his statement. There is inconsistency between this contention and the claim that there was invention in operating the Berliner-Reis instrument by Bell's method. If it was obvious, upon a reading of Bell's patent, and upon learning the capacities of an undulatory current, that the Reis instrument could be so operated as to produce Bell's undulatory current, then there would have been no invention in using the old method with an old instrument. The Supreme Court in 126 U. S., page 545, said, concerning Van der Weyde:

"It is only necessary to say that he copied Reis, and it was not until after Bell's success that he found out how to use a Reis instrument so as to make it transmit speech. Bell taught him what to do to accomplish that purpose."

This raises a doubt whether the mere discovery that the Berliner-Reis instrument could be operated by the Bell method constituted a patentable invention. The Supreme Court also said, "With the help of Bell's later discoveries in 1875, we know now why he (Reis) failed." "It was left for Bell to discover that the failure was due, not to workmanship, but to the principle which was adopted as the basis of what had to be done." The argument that the caveat is a full reduction to practice, irrespective of experimental results, is based upon the assumption that Berliner, as an inventor, must have realized that what he had written down was necessarily true. If so, patentability must be denied on the ground that the caveat was a simple following of Bell. Mr. Storrow argued (126 U. S. 288), as to the operativeness of the Reis apparatus:

"If this were true it would only show the perfection and the novelty of Bell's new method or mode of operation, which, when applied, would enable that which never had been a speaking telephone, to at once transmit speech."

There is force in this argument. The complainant's case as to invention, however, is based upon the contrary assumption and upon proofs to the contrary.

Professor Cross says:

"There was certainly no reason to justify a scientific man in asserting that, under the slight change of pressure due to the voice, the variations of resistance correspond to and are approximately proportional to the variations of pressure, and are great enough to yield practical results. This," he says, "was not wholly unknown, but what was known on the subject tended to show that the operation expressed by this law was an impossibility."

How can it be claimed, then, that, aside from experimental results, a mere statement in writing, which was upon its face a statement of something that could be known only empirically, is equivalent to complete invention? Professor Wright says:

"There is another principle which is utilized in the case of any microphonic transmitter transmitting speech, and that is the proportionality between the variations in the current strength and the variations in the pressure at the point of contact produced by the vibrations of the air caused by articulate speech or other sound. So far as I am aware, this principle of proportionality was not known and had not been utilized for any practical purpose before the time of Berliner's invention described in his caveat."

The contention that the caveat establishes invention because in some cases invention may be established by drawings and verbal descriptions fails to recognize the distinction between inventions dependent upon familiar facts or familiar mechanical principles, and an experimental invention based on the discovery of new facts. A drawing or words may or may not prove completed invention, according to the subject-matter. If common persons guided by common knowledge, or experts, or scientific men, guided by scientific knowledge, can say, upon reading text or examining a drawing, "this will necessarily work, it accords with what is known," then there may be reduction to practice by a drawing or by a verbal description.

If, upon reading a document or studying a drawing, scientific men and experts would say, "all that is known tends to show that this is an impossibility, or there is nothing in common experience or in expert or scientific knowledge which justifies this statement without experiment,"—if it will not be believed without experimental verification,—there surely is not patentable invention in the writing down of the project. It is bare hypothesis. The contention is based upon a quotation from the *Telephone Cases*, 126 U. S. 536:

"The law does not require that a discoverer or inventor, in order to get a patent for a process, must have succeeded in bringing his art to the highest degree of perfection. It is enough if he describes his method with sufficient clearness and precision to enable those skilled in the matter to understand what the process is, and if he points out some practicable way of putting it into operation."

As the Supreme Court held that Bell's description of a process of treating an electrical current was sufficient to sustain his patent, though Bell had not transmitted speech prior to the date of his application, the complainant seeks to place Berliner on a par with Bell as the inventor of an art or process, and thus to avoid by the caveat the effect of the denial in the application and the imperfection of the evidence as to experiments. But there is no analogy between Berliner's secret caveat of April 14, 1877, and Bell's specification.

Bell made a most remarkable primary invention, and described exactly a process based upon a scientific conception—"a mathe-

matical conception." 126 U. S. 539. His patent was "not to be confined to the mere means he improvised to prove the reality of his conception." The Berliner caveat does not purport to describe and does not describe a new process of treating a current, but upon the most favorable construction merely apparatus for practising Bell's art,—novel not as structure, but as an old structure applied to a new use. A structure that had failed as a speech transmitter under the efforts of Reis, Edison and others. It states that the pressure between the plate and the metal ball can be regulated by a thumb screw, but the success of the apparatus is dependent upon the operator's finding out for himself the exact adjustment of each instrument. It is clearly shown by the evidence that to obtain the exact adjustment and conditions necessary for the transmitter is a matter requiring great care and skill, and that the adjustment that is essential for the transmitter is unsuitable for the receiver. If this caveat is now a direction sufficient to a person skilled in the art, Berliner was not so skilled,—but an uninformed experimenter. The caveat may be followed as far as its directions go without success. A feat of experts must be added to what is shown. Professor Cross says:

"With every microphone there is a certain 'normal pressure' as it is called, which should exist between the electrodes when at rest, in order to secure good microphonic action. . . . It is a well-known fact that the electrodes of an ordinary microphone transmitter will not operate to transmit speech if they are closely clamped together."

Professor Wright says:

"When transmitting speech, the electrodes of the microphonic transmitter are brought together with a pressure that is very slight, and which has been determined by experiment to vary within a comparatively narrow range." He says, also: "I have ascertained by numerous experiments made with a great variety of microphonic joints that with all combinations which are ever practically used in transmitting microphones, there is a certain interval between the smallest pressure and the largest pressure practicable, within which the changes in the intensity of the current are very closely approximate to the changes in the pressure which produce them."

We have already referred to the evidence of Professor Wright, "that the mechanical conditions under which each best performs its functions are also very different." The caveat discloses nothing of all this, it does not prove that Berliner had found out the "certain interval between the smallest pressure and largest pressure practicable" for his transmitter, nor the suitable adjustment for his receiver. It affords less evidence, even, than his oral testimony, and certainly cannot mean anything more. Therefore, when we find that his caveat was based upon a single experiment with the two instruments; that he afterwards made the double-pin instrument and applied for a patent upon it, and declared the uselessness of his caveat transmitter, it becomes necessary to conclude that Berliner, as a matter of fact, did not accomplish what he hoped to accomplish; that he stopped where Reis did. And, in the face of such a conclusion of fact, there is no artificial rule of law that makes Berliner's caveat description a reduction to practice. It is merely a part of the evidence, one of several documents all equally relevant. In *United Telephone Co.* v. *Harrison,* 20 Eng. Rul. Cases, 602, it was said:

"How can we, dealing with a subject like electricity (a subject which at the present moment is so obscure that I am not sure that scientific men would pledge themselves now to the exact way in which the transmitter works), and going back six years into the twilight of the discovery, say that an instrument which presents no means of knowing what the best adjustment was, is the same instrument as that which does."

How can we say that Berliner's caveat, which shows substantially the Reis apparatus and does not show what experts say is essential to make it transmit speech, is the equivalent of a reduction to practice? The evidence of the experts as to the absolute necessity for a loose contact accurately adjusted seems to establish the insufficiency of Berliner's caveat to prove that he had discovered any of "the remarkable properties of a loose joint."

So far as efficiency and difference in electrical effects are concerned, the caveat is silent. Berliner's problem, after receiving from the Morse key a suggestion, and after finding by galvanometer tests that a variation of current could be produced, was still before him. He had no theoretical grounds whatsoever upon which he could state anything more than that some variation of the current might follow.

Upon the evidence of complainant's experts, it was a known fact that changing the firmness of contact of solid electrodes would change a current, and the problem was to find whether it could be changed in a sufficient and proportional amount by the vibration of a diaphragm. If Berliner did not by experiment discover this his pretensions are baseless. Berliner's invention, if he made one, lay in experiment. He was entitled to formulate an expression of what he had found out by his experiments. He was not entitled, either scientifically or legally, to lay a claim to anything more. It was necessary, before the forecast expressed in the caveat was entitled to be called a conception from which invention could date, that Berliner should have found not only that he could produce some variations of a current, that he could get something of the quality of speech,—but that he should have produced substantial effects that were a demonstration to the ear of the truth of his project. Edison had changed a current with a Reis instrument and produced audible effects in 1876; Edison's attempt to operate a Reis transmitter without breaking the current anticipates Berliner's conception, and he had demonstrated that a current could be changed. If this is all Berliner did, if this is all the caveat proves, he is anticipated by Edison's experiments with the Reis transmitter.

In Robinson on Patents, Sect. 381, referring to inventions which are the result of experiment, it is said:

"The production of a new means by this method is . . . . . an inventive act, but at no instant before the experiment succeeds can it be said that the conception of the invention exists in the inventor's mind. Until that instant, it is mere speculation, as a probable deduction from facts already known; and the same act which reduces it to practice gives to the conception its definite and final form."

This I believe to be sound. One who should read this caveat would find in it nothing self-evidently true or conformable to experience. He would be obliged to take the author's word for it as a statement of fact resting on authority. Counsel contend that the belief of Berliner that he could not transmit speech would make no difference. They say:

"He had invented, described and pointed out a mode of operation, a method of varying resistance in the circuit by varying pressure, which necessarily does result in a capacity to transmit speech. It is not the mere fact that speech is transmitted, which is the thing that is claimed in this patent. It is the discovery and invention of a method of varying resistance in a circuit which is of supreme value, because, whether known to the inventor or not, it will transmit speech and all other sounds, and will necessarily mold a battery current as is necessary to mold it to transmit speech."

Here counsel are claiming for Berliner what Bell's patent claim 4 covers completely. The only method of varying resistance, whatever its kind, is Bell's—to vary it by and proportionately to the pressure exerted by sound waves. Berliner, of course, knew what Bell's undulatory current could do if he could produce it,—his problem was either to produce it or to approximate it by a composite operation of breaks and weakenings; but he did not know, merely because he could produce deflection of a galvanometer, or something of quality, that he could produce Bell's speaking current (see 126 U. S. 299, 302, 303) any more than Reis did. It is here contended, practically, that if Berliner found out that, by pressing together two electrodes, he could change a current, he was entitled to leap to the conclusion that he could produce any and all changes of a current; that he could vary it in the required proportions, and that upon this he became entitled to lay tribute upon all practical experimenters. But the patent law affords no protection to speculators nor to prophets. If the conclusions of fact are sound, and Berliner's caveat—as upon the evidence I am forced to believe—was merely a clever hypothesis reduced to text and drawings, no case could present a more forcible example than this of the necessity of drawing the line between the speculator and the inventor. A failure to draw this distinction, and the apparent failure in the Patent Office to give to the caveat of May 9 the same force as evidence as that of April 14, together with the acceptance of insufficient evidence of mistake, has led to the conversion of an abandoned scheme into a patent that has for ten years been asserted unjustly against the public right. Edison by countless experiments succeeded in advancing the art. Berliner's secret caveat would never have given the world a speech transmitter. It was embryonic, inchoate, and rested in speculation. Because of his application of June 4, 1877, the authorities that the complainant's brief quotes against Edison are applicable with full force to Berliner and his caveat when it is resurrected and asserted adversely to Edison.

"The law requires not conjecture, but certainty." *Coffin* v. *Ogden,* 18 Wall. 124.

As skill in language and in scientific method becomes more common, it is easier for speculators to survey and cover the field opened by new discoveries; it is easier to generalize as to what may be done, and to mark out the general lines upon which progress must be made, than to accomplish practical results. But the work of practical men should not be hampered by finding a new, useful and practical device covered by some patentee who was able to make generalizations applicable to all that might be developed within seventeen years from the date of a paper patent. It surely was not the intention of the Supreme Court to decide, and the Supreme Court did not decide, that he who guesses is an inventor if he writes down in a secret memorandum clever guesses or projects which are verified by others. If this is the correct interpretation of the decision, the speculator has only to make broad and expansive generalization, and await the issue of the necessary labors of practical experimenters. If their efforts fail, he has lost his paper and ink. If their efforts succeed, he may exact tribute from those whose efforts have led to practical results.

The complainant's attempt to base the case upon this caveat, irrespective of Berliner's experimental results, involves it in a curious situation. Professor Cross says, in effect, that what was known on the subject tended to show that what Berliner wrote in his caveat was an impossibility. Counsel say it was "an invention until it had been accomplished, of incredible character." It is said that the invention was based upon Berliner's discovery of the availability of solid electrodes to effectively vary the current in the required way. By writing the caveat regardless of what he knew experimentally, Berliner made an invention because what he wrote was true in fact, and therefore necessarily true at the time it was written down. Although on its face an apparent impossibility, Berliner must have realized that what he wrote was true, even if he did not make the experimental discovery. That even if at a later time he became convinced that what he wrote was an impossibility, as it appeared on its face to be, and stated in his application that it was an impossibility, he was an inventor because other persons have made the discovery that his later statement was untrue and that his first statement was true, and therefore he was entitled to amend his application by striking out the major part of it, and inserting large portions of his caveat. To make a case, even upon such an argument, it must go one step farther and say that he might amend even if, at the time of making the application, he had not intended to claim what was in his caveat.

The real question is not whether this caveat would have been good as an application for this patent, but whether, as a matter of fact, Berliner had made any discoveries that render it probable that his application stated what he did not intend to state, or that

he intended to claim his single-pin instrument for speech transmission. As we have said, if there is an artificial rule of law that makes this caveat an invention, though Berliner did not know it, there is no artificial rule of law that attributes to him an intention to make an application for a speech transmitter when he was of the opinion that he had not invented one. Therefore, the contention that the caveat is a reduction to practice, if established, would be insufficient to support the complainant's case.

When Berliner filed his application, he left it open to others to discover that speech could be transmitted with a diaphragm and a metal pin. The expert who first succeeded in doing so is entitled to the credit of making that discovery despite Berliner's caveat. The case cannot, upon any view, be maintained without proof of experimental success. I am of the opinion that this proof is necessary in order to establish invention; but, if this is not so, I think that there can be no doubt that it is nevertheless still absolutely necessary in order to show that Berliner, on June 4, 1877, intended to make application for what is covered by the patent in suit.

Even after the mind has been conciliated by the course of argument adopted in the complainant's brief, and if a comparison of Berliner's original application and his patent is preceded by the detailed statement of all the circumstances favorable to Berliner, and the argument of experts upon his application, yet, after all this, the conscience is shocked when Berliner's application and his patent are compared; and a shock to the intelligence also occurs when we are told that the clear, specific and detailed statements of Berliner's application were mistakes of a solicitor's clerk, who was ignorant of the subject, and therefore must have got all his information from Berliner.

The patent, then, is invalid: First upon the ground that it issued for an invention which Berliner had not made at the time of the application; and, second, upon the distinct ground that it issued for an invention not disclosed by or claimed in the original application, and not incorporated into it by legal amendments.

The next question affecting the validity of the complainant's title is the defendant's point that the patent in suit is void because of Berliner's earlier patent No. 233,969, of Nov. 2, 1880. This is known as the Receiver Patent, and was issued upon a division of the original application. It contains a sufficient description of the transmitter to sustain a claim if Berliner were seeking it. Counsel for the complainant concede this. It is sufficient to consider claim 4.

"Claim 4. A system of two or more telephone instruments in electrical connection with each other, each consisting of two or more poles of an electrical circuit in contact one with the other, either or both poles of each instrument being connected with a vibratory plate so that any vibration which is made at one contact is reproduced at the other, substantially as set forth."

This claim is for two single-pin instruments in a system. Each is a relative part designed 1or and only useful in a system. They are system parts or relative instruments. In the system, each performs its whole function, and alternately the functions are reversed. We find, therefore, in this claim, the transmitter performing its entire function of producing electrical undulations similar in form to sound-waves, and applied to its appropriate use in connection with a receiver. This claim embodies the transmitter completely. Its intended function is in no way modified by the fact that it is united with a particular receiver. It performs with this receiver the same function as with any other receiver. The complainant contends that this claim is for a combination which is an invention distinct from either the transmitter invention or the receiver invention. I am of the opinion that this contention is unsound. As the transmitter is a system part or relative part, it does not constitute a combination in the sense in which that term is used in patent law, to put the system part into a system for which it is designed; to put a relative instrument into its intended relation. This is but application to appropriate use. No third person would have been entitled to a patent for a combination by uniting two of these instruments. There is no invention over and above that which is in the transmitter and that which is in the receiver. A "transmitter" implies a receiver, a "receiver" a transmitter.

The fourth claim, nevertheless, is not invalid, because Berliner was the inventor, we may assume, of both; and he might take a patent with such limitation upon the use of either as he saw fit. He could not, however, take a patent for his transmitter limited to its appropriate use with a single receiver, and subsequently take out a patent that would enable him to control any and all uses of the transmitter, since the latter patent would include the former use, for which he had already received a patent. It is a valid claim, because, as we may assume for this argument, the elements were novel, and Berliner was the inventor of both. The claim confers a monopoly of the transmitter with a restriction or limitation. The patent in suit confers a monopoly without restriction. The patents are, nevertheless, both for the "same invention," both in a legal and a practical sense. It presents the familiar case of an inventor taking a patent with an unnecessary limitation. The commissioner has exhausted his power and cannot afterwards give him a general grant for all uses. The argument that the use of the transmitter or of the receiver alone would not infringe claim 4 is immaterial; it does not prove tnat the claim is for a third invention, but merely that the claim does not cover all the uses which might have been covered, had the patentee not chosen to take a claim for a restricted use.

That the two patents are not co-extensive does not affect the application of the rule against double patenting. The patent of 1880 gives Berliner full protection for his transmitter in a particular application to an appropriate use. It is said that in electrical apparatus the word "system" has just the same meaning as the word "combination" in purely mechanical apparatus. Berliner's 1880 specification does not, however, disclose any invention in the coupling of his instruments, but merely elements united without invention. In *Palmer* v. *Brown Mfg. Co.*, 84 Fed. Rep., page 454, it was held that a claim purporting to be for a combination was, in fact, simply for an application to an appropriate use of what was claimed in an earlier patent, without the development of the inventive faculty in making the application. Though the Circuit Court of Appeals disagreed with the Circuit Court upon the question of whether or not there was a true combination, and sustained the patent on the ground that there was a true combination, it said, "The test of identity afforded by a comparison of the claims of the two patents, however, is not conclusive. We must be satisfied further that there are substantial differences, not merely varying descriptions of one invention, or descriptions of a single invention in different applications to use." There was no disagreement with the views of the Circuit Court upon the legal proposition that, where the difference between two patents was that one was for a specific device and the other for a specific device applied to its appropriate and intended use, the patents were for the same invention. *Palmer* v. *Brown Mfg. Co.*, 92 Fed. Rep. 925. See also *Palmer Pneumatic Tire Co.* v. *Lozier*, 90 Fed. Rep. 732. That the claim also covers the instrument when performing its functions as a receiver is immaterial. The reference in the 1880 patent to the application for the patent in suit, if intended as a reservation, does not avail.

Miller v. *Eagle Mfg. Co.*, 151 U. S. 186, 192, 201.
Palmer Pneumatic Tire Co. v. *Lozier*, 90 Fed. Rep. 745.

Without considering other grounds based upon other claims of the 1880 patent, I am of the opinion that, by granting claim 4, the Commissioner exhausted the power to issue the patent in suit.

I agree with the conclusion of Judge Carpenter upon this point, in *United States* v. *American Bell Telephone Co.*, 65 Fed. Rep. 86, 87. On appeal and in the Supreme Court, this finding was not overruled as erroneous, but only as unauthorized on a bill by the Government for the cancellation of a patent.

We have next to consider the questions arising on the work of Edison. Berliner's amendment of Aug. 8, 1877, must bear the date of filing. The date of the application for the patent in suit was not earlier than Aug. 8, 1877. On this view, Edison's application of July 20, 1877, for patent No. 474,231, is so clearly an anticipation of all that is claimed for Berliner by the complainant that we need not dwell upon it. Professor Cross says of the apparatus described in this application:

"I have no doubt, therefore, that the apparatus . . . was in fact, what it has universally been admitted to be, a microphone."

See also 126 U. S., p. 278. Professor Cross says, also:

"But although the apparatus . . . was a microphone in fact, my belief is, that Mr. Edison at the date of his application . . . and indeed long subsequently to this, believed that the apparatus operated by variations of the mass resistance of the material employed in the points."

But this, of course, is entirely immaterial. Here is the place for the proper application of the rule: "An inventor is not called upon to state and explain the principles of nature involved in the operation of his invention." Robinson on Patents, Vol. 1, Sect. 82; p. 124, Note 3.

Disregard all Edison's explanations or notions as to the scientific reasons for the success of his invention,—its success still remains. Edison's application describes and claims the invention; and does not, like Berliner's application, contain evidence that the applicant had not made and did not intend to claim it. Edison's application of July 20, 1877, throws upon the complainant the burden of proving that Berliner had made the invention of the patent in suit before July 20, 1877. This burden cannot be sustained.

But, if we assume that Berliner did make an invention, and that his caveat of April 14, 1877, counts as a full reduction to practice, the complainant has still to meet the defence of the priority of Edison.

It is impossible in this opinion to consider all the contentions that arise on Edison's work, or all the relevant experiments, patents and apparatus. It is proven, however, that before the event in the telegraph office that suggested to Berliner the possibility of employing in telephony variable pressure or variable contact of solid electrodes, Edison had been engaged for a long time in experiments to find means to mould a battery current into undulations similar in form to sound-waves; that he always used a continuous current and the vibrations of a diaphragm to control the approach and recession of conducting surfaces in constant contact. With various devices he had succeeded in getting some degree of articulation. As early as 1876 he had experimented with a Reis transmitter, and obtained results which he describes as follows:

"Q. Did you succeed in transmitting any words with it at that time?
"Ans. I cannot say; we generally knew what was coming, and, knowing what was coming, even a Reis transmitter pure and simple transmits and reproduces sounds which sound almost like that which is being transmitted; but when it was attempted to transmit something which the receiver did not know, it was very seldom that any word was recognized."

He rejected that as useless. By Jan. 20, 1877, he had thought of applying to the telephone the fact, discovered by him in 1873, that carbon placed in an electric circuit and subjected to varying pressure gave rise to remarkable variations of current. At this date he made an experiment which he says "was the first attempt to apply the property of carbon, of varying its resistance by pressure, which I discovered in 1873." This experiment was illustrated and explained by the following sketch and inscription:

"Three platina points don't seem to work any better than one point; get it very good on a Western Union relay through my teeth, but I think that I

could get it better if I had an adjustment to it, for Charley can't hold it steady enough."

Edison testified:

"It consisted of a diaphragm and three platina points immersed in a dish containing loose carbon. The talking, though very poor in quality, was of a suffi-

EDISON TRANSMITTER.

cient volume that it could be heard through the teeth when an ordinary Morse relay, the magnet of which was included in a circuit, was held against the teeth."

This preceded what counsel say was Berliner's date of conception, late in January, 1877.

It is clear, however, that Berliner's thought in the telegraph office was not a complete conception from which invention can date, but, as counsel say, "only an imagination of a possibility based upon analogy." He had merely found a line of investigation,—something worth looking into,—and conception was incomplete until experiment led to discovery. The conception could date only from such discovery. *Clark Thread Co.* v. *Willimantic Linen Co.*, 140 U. S. 481, 489; Robinson on Patents, § 381. Before this, even, Edison had made and recorded an experiment embodying the idea from which was developed the successful commercial telephone,—the use of a carbon electrode; and also, constant contact and variable pressure upon a solid.

The evidence of complainant's experts proves the importance of this experiment. In order to show that the defendant's carbon powder transmitter infringes, Professor Cross testifies that variations of current produced by varying pressure on a single contact and on a mass of powder were recognized by Du Moncel and Sir William Thomson as different examples of the same principle; and that "the mass of powder merely furnishes a large number of microphonic contacts." If Berliner is to be given a date of conception, "late in January, 1877," Edison surely, upon the same line of reasoning, must be given an earlier date. His conception was embodied in an experiment; and, following this, it appears that, during January, February and March, Edison and his assistants were busily engaged in taking advantage of the properties of carbon. This experiment, crude as it was, preceded Berliner's experiments to find whether pressure between a diaphragm and a metallic electrode would deflect a galvanometer. The importance of this experiment is that, if we adopt the complainant's view as to what constitutes a complete conception, we are obliged to give priority to Edison on this experiment alone, in the light of Professor Cross's testimony as to a mass of powder. By Feb. 9, 1877, Edison had succeeded in transmitting speech "commercially," as he says, by apparatus which we have already illustrated, and upon which was based his application of April 27, 1877, for patent No. 474,230. The complainant's brief says that "The question whether Edison or Berliner first made a variable-resistance transmitter with solid electrodes, in which the external resistance may be varied, as Bell's patent says, has never been presented to a court until now." That Edison did produce speech with solid electrodes before Berliner is clearly proven; and the invention described in his patent No. 474,230, applied for April 27, 1877, has as its true date Feb. 9, 1877. This was before the earliest date given by Berliner in his statement in interference, March 4, 1877, when, as he said, "a person heard sounds, but could not generally make out the words that I spoke," and concerning which the person testified that he heard no words.

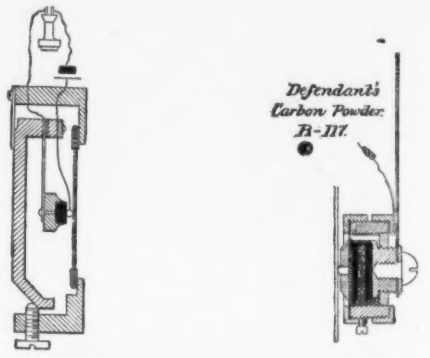
But upon no reasonable view of the testimony of Berliner himself can we give to him a date for the transmission of any words earlier than April 11 or 12, 1877—the second date given in the statement in interference. If Berliner made an invention his date is not earlier than April 11, 1877. Before this date and by April 3 or 4 Edison had successfully transmitted speech, with other apparatus already illustrated, consisting of a diaphragm and "five vertical springs, each provided with a sleeve carrying a cylinder o· button of hard-pressed plumbago fastened to a bar of insulating material. All the plumbago buttons were in contact, and the one at the end rested against the diaphragm. The circuit was complete from the first spring through all the carbons to the last spring." The instrument transmitted ordinary speech perfectly.

The complainant's counsel admit that the apparatus of April 1 1877, is a transmitter involving the conception that the extremely minute vibrations produced by the human voice could produce sufficient pressure of one electrode upon another to change the current, since they contend that it operates by compressing the mass of the second electrode.

Preceding Berliner's caveat and his earliest date are at least three operative constant-contact transmitters employing a battery current, using the sound-waves as the motive force, and producing electrical undulations of the kind described in Berliner's patent; two of them having solid electrodes, and all of them practising the variable-resistance method of Bell, and all causing the current to vary proportionally to the pressure exerted at the diaphragm, and also proportionally to the pressure exerted by one electrode upon another; strengthening and weakening the electrical contact according to the movements of a diaphragm, increasing it as pressure increases, decreasing it as pressure decreases; and all embodying what is said to have been Berliner's radically novel conception, e. e., that sound-waves could produce sufficient pressure between contact electrodes to produce an undulatory current.

Many difficulties in this case arise from the complainant's attempt to show that Berliner's patent embodies a conception that was a radical novelty, and a mode of operation that was novel and generic; and to frame a generalization broad enough to include the defendant's devices (by disregarding differences in structure that are so material and important as to render any comparison in respect to practical efficiency or commercial utility out of the question), and that also will escape anticipation by the devices of Edison. If Berliner's invention was in fact merely an invention of apparatus for practising Bell's method, and is to be considered merely as an improvement upon the apparatus of Bell and Edison, there is clearly no infringement.

The defendants' "single contact transmitter" is substantially the well-known Blake transmitter, in which the contacts are of platinum and hard carbon, each supported on springs. This is described in Letters Patent to Blake, No. 250,128, dated November 29, 1881. The contacts are spring supported, so that they move with the diaphragm. The electrode of hard carbon shown in solid black in the drawing will demand particular attention. The second, or wall form, also employs carbon, powdered and enclosed in a cell, which cell is carried by a leaf spring. The cell is almost, but not



FORMS OF CARBON TRANSMITTER.

quite, filled with granulated carbon, leaving room for motion and expansion of the particles of carbon. Two conducting plates or carbon plates form the front and rear walls of the cell. The movements of the diaphragm are communicated to the front wall of the cell, which presses more or less against the adjacent carbon particles, and likewise presses the numerous carbon particles within the cell into more or less intimate contact. This is said by complainant's experts to be a "multiple contact" transmitter.

The use of carbon in a transmitter is beyond controversy the invention of Edison. Edison was the first to make apparatus in which carbon was used as one of the electrodes, and Berliner, in the course of proceedings in the Patent Office, disclaimed carbon as an electrode. Professor Cross testifies that "No metal contacts of which I know could compete with carbon for practical commercial use," and that "All commercial transmitters, as far as I know, have employed carbon as the material of at least one of the electrodes." The carbon transmitter displaced Bell's magneto transmitter; and, under several forms of construction, remains the only commercial instrument. A transmitter with metal electrodes was never in commercial use, the magneto instrument being a better instrument for the practical transmission of speech than a Berliner transmitter with metallic electrodes. The advance in the art was due to the carbon electrode of Edison. Edison's structure, then, is distinct from the structure of Reis or Berliner, and was patentable as apparatus, and was an invention of very great importance. The complainant is attempting to subordinate a great invention. It is contended, however, that Berliner's invention was generic, and that it both precedes and includes the carbon transmitter. To sustain this contention is essential to the complainant's case, for otherwise the disclaimer of carbon is fatal. Berliner's transmitter and the defendants' transmitters are classified by the complainant's experts under the name "microphone," a name which, so far as applied to telephonic apparatus in commercial use, signifies that one of the electrodes is of carbon. The term was applied by Hughes in 1878 to designate apparatus invented by him, having carbon contacts, and designed to render very feeble or inaudible sounds with such intensity that they would become audible. This apparatus rendered audible the tramp of a fly. Professor Brackett says: "In some loose sense, the term 'microphone' has come to be applied to any kind of a loose contact variable-pressure transmitter when employed for telephonic purposes. It is quite clear that such use of the term is not descriptively accurate." He refers also to confusion in discussions relating to telephony likely to arise from the use of this term.

As we have to consider whether or not apparatus with an electrode of carbon is similar in substantial respects and in mode of operation to one with electrodes of metal, and embodies the same invention, the constant use of the term "microphone" by the complainant as descriptive of Berliner's apparatus is somewhat confusing, since it involves a begging of the very question that we

have before us; and assumes that Berliner's apparatus is substantially similar to that of Edison and of Hughes. It is apparent, however, that Berliner did not anticipate the remarkable discoveries which Hughes disclosed to the world in 1878, and that these discoveries of microphonic facts should not be read into the patent of Berliner. These discoveries were not due to a "conception" but to investigation by intelligent experiment. No preconception could have embraced what Hughes discovered experimentally. Moreover, the apparatus of Hughes did not include a vibrating diaphragm. Nor should we be misled by the complainant's statement that the instrument described and claimed in the patent "is the only instrument capable of successful use in the transmission of articulate speech by electricity over such distances and in such situations as those for which the telephone is most practically useful and has hitherto been chiefly used." This is true of transmitters with an electrode of carbon, but not of Berliner's instrument. It is true of the carbon "microphone transmitter," but not of the metallic "microphone." It does not follow, because there may be resemblances between the instruments of Berliner, Hughes and Edison, upon which, in the light of subsequent knowledge and disregarding questions of practical utility and substantial differences in structure as well as the history of the development of practically efficient apparatus, all, as well as the old Reis apparatus and the Morse key, may be classified ex post facto as "microphones," or because there may be scientific resemblances between them, that the instruments are to be regarded as substantially resembling each other in the practical sense of the patent law, which is governed by considerations of utility rather than by the classifications of science.

What, then, was Berliner's invention according to the complainant? "Berliner's inventions do not reside in the structure involved." This is one of the reiterated propositions of the complainant's brief and argument. It is said that Berliner, "using substantially the old Reis structure, produced a new mode of operation." It is this "mode of operation" which the complainant seeks to monopolize. Identity in respect to mode of operation is proposed as the test of infringement. The complainant's use of the term "mode of operation" requires most careful scrutiny. Counsel say that Berliner's invention may be phrased in many ways; that it may be called an instrument "characterized by its mode of operation," an art, or process, or method; and that these different expressions are essentially the same. The case of the complainant rests upon the proposition that Berliner invented a "mode of operation," or process, or art. It is necessary, however, to draw a careful distinction between the "mode of operation" or modus operandi of an instrument, and a process or mode of operating upon an electric current, and a way of operating a Reis machine in order to preserve constant contact of electrodes. What is Berliner's "mode of operation," art or process or method? The patent covers no new process to be practised upon an electric current. The process performed upon the current is Bell's and is disclaimed. Neither the caveat, application nor patent refers to any novelty in the treatment of the current. The patent covers no new method of varying resistance, disclaiming varying resistance by sound waves. We have seen the fallacy of contrasting Berliner's "mode of operation" with that of Reis, since by this means the Berliner patent is made to cover again a portion of Bell's field of invention. Berliner's mode of operation must be contrasted with that of Bell's liquid transmitter and of Edison's apparatus. I believe, however, that this fallacy is essential to the complainant's contention that Berliner invented more than a mere variation of apparatus, operating according to the general method invented by Bell and applied by Bell and Edison.

According to the complainant's evidence, when the electrodes of Berliner's instrument transmit speech there are two joint effects produced by the vibration of the diaphragm: 1. The varying pressure of the electrodes, one upon another. 2. The varying discontinuity of the joint; in other words, the weakening and strengthening of contact. Each of these effects is in turn abstracted and selected by the complainant as the cause or explanation of the variations of the current, and erroneously termed a process, art or method, and we find either two explanations or two modes of expressing the same thing: 1. The mode of operation by variable pressure. 2. The mode of operation by varying transition resistance, to wit, the resistance due to the discontinuity of a loose joint.

We will first consider the "mode of operation by variable pressure." The argument follows the language of the claims and specification. Counsel attribute to Berliner the following conception: "I have a solution. I am going to vary the battery current by varying the resistance of the circuit—how? By varying the pressure between the electrodes by the operation of sound vibrations." In other words, he says: "I propose, as a means of solving this problem that many men and many minds have been engaged in, the following solution. It is a simple one. It is a precise one. I will vary the pressure as such between the electrodes which form a part of the circuit. Your Honor will, I think, observe the precise and yet the satisfying character of that solution. It seems to me that it is neither too broad nor too narrow." The complainant's brief says:

"Berliner's idea of using the extremely minute vibrations produced by the human voice to vary the pressure between contact electrodes, so as to produce an undulatory current, was radically and absolutely new."

Professor Cross states that the operation of the transmitter depends in part upon these facts: First, variation of contact pressure at the electrodes produces variation of electrical resistance; second, that under the slight changes of pressure due to the voice, the variations of resistance correspond to and are approximately proportional to the variations of pressure, and are great enough to yield practical results. The first fact, he states, was known but not utilized. The second, he says, was wholly unknown before Berliner. Counsel also describe Berliner's invention in the following language as "the discovery . . . of the availability of pressure, as such, between electrodes, when varied by sound-waves, to vary the electric current in the required way." All this is too abstract, indefinite and vague. It disregards essential conditions and does not escape anticipation by Edison. If this is a full expression of Berliner's conception or discovery, then it is clearly proven that it was an erroneous and inadequate conception. Unless by the words, "varying pressure" is meant varying contact, all this is proven to be erroneous by the complainant's own evidence. A turn of a screw disproves the variable-pressure "mode of operation." It is not true that when electrodes in contact are brought together with greater pressure the resistance proportionally decreases; and conversely, when the pressure is diminished the resistance proportionally increases. If the screw is tightened so that the electrodes are clamped closely together there will still occur changes of pressure "between" electrodes proportional to the pressure upon the diaphragm, but the current will not be affected as desired. Here we have the best example of pressure "as such," but the current does not change. It is only when the electrodes are placed in loose contact so that changes of contact occur, and so that the contact is loosened and tightened, that changes of pressure are accompanied by changes of current. Eliminate these changes of contact and the cause of the variation of the current disappears. The "law of variable-pressure" is unsound, practically, and logically is misleading. It gives a nominal pre-eminence to that condition which is present both when the instrument is operative and when it is not. It serves to divert attention from the essential condition—variation of contact—and from the general resemblance of Bell's, Edison's and Berliner's modes of operation. Counsel mean by "variable pressure" variable contact. Berliner's variable pressure is a species of variable contact, and variable contact produced by sound-waves is the invention of Bell, and was used by Edison before Berliner.

Professor Brackett says:

"With the general statements of Professor Cross as to variations of pressure causing variations of resistance, I have no hesitation in agreeing if the intermediate results be kept in mind, or if need be carefully stated, otherwise not."

He says also:

"I do not conceive that any special function is to be attributed to pressure merely as such, except in so far as it operates to produce a change in the amount of area in contact, or in the proximity of molecular areas which the electric current is to pass."

Professor Cross testifies:

"If the instrument is described as working by variation of pressure, that itself is a description that the contact is constant. The instrument could not work by variation of pressure unless there was constant contact."

But the words "variation of pressure" must mean not only constant contact, but varying contact as well. The instrument cannot work unless the contact is both constant and variable. By its "mode of operation by variable pressure" the complainant seeks to cover all transmitters operating upon a battery current by constant but variable contact of solid electrodes, "solid" being the only limitation it contends for as implied in the word "pressure." Is the complainant entitled to hold these defendants as infringers because their transmitters operate by varying pressure or varying contact of solid electrodes, or because Berliner first discovered that the minute vibrations of a diaphragm could produce sufficient changes in the contact of solid electrodes to transmit speech, or because he was the first to invent apparatus embodying the conception that sufficient pressure could be produced between electrodes to vary the current in the required way, or in which the pressure was intentionally weakened in order to cut down the current? Edison's apparatus of February 9, 1877, and April 1, 1877, anticipates all this, and shows that Edison before Berliner had discovered "that a force so feeble as that of a sound wave" could so vary the pressure between electrodes in constant contact as to produce the electrical undulations required for the transmission of speech. If the variable-pressure operation can be saved from anticipation by Bell through a distinction between a solid and a liquid electrode it cannot thus be saved from anticipation by Edison. The variable-pressure mode of operation limited to solid electrodes is anticipated by Edison, and the claims limited to solid electrodes are also anticipated.

So long as the complainant's counsel persist in pointing out as Berliner's novelty a single aspect of what occurs in the operation of his transmitter, and which occurs in all constant-contact transmitters, to wit, "variable pressure between electrodes" and insist that this is the ground for comparison in determining whether other devices infringe; so long as counsel insist that they need give no further description of the necessary apparatus than "electrodes in constant contact" or "solid electrodes in constant contact," or such vague description of apparatus as may be implied in emphasizing the words "pressure as such,"—so long must they submit to anticipation and to the destruction of their argument by each device that comes within the natural meaning of the broad, general terms whereby they seek to include the defendant's transmitters as infringements. The complainant cannot identify the defendants' transmitters with the defendants through so broad a generalization as "variable pressure between electrodes" or "variable pressure between solid electrodes," for, in making these gen-

eralizations so broad as to encompass the defendants, they at the same time so broaden the field of anticipation that they include prior devices of Edison.

Edison's application of April 27, which goes back to February 9, 1877, showed a diaphragm of sheet metal, in front of which was a plate or disk of suitable material having a conducting surface. He says, "I found that a disk of hard rubber coated with plumbago answers well, but a disk or some conducting metal or substance may be employed." He describes the adjustment and operation. There are two alternative adjustments, by one of which the circuit wires are contacted at opposite sides of the disk, when the apparatus is not within the terms of Berliner's patent. Another adjustment shown, however, is one wire connected to a disk and the other to a diaphragm. This is the arrangement shown in the drawing previously shown in this opinion, and dated February 9, 1877. "The disk or plate is accurately adjusted to the proper proximity to the surface of the diaphragm so that in a state of rest there will be little or no current passing from the battery upon the line; but the vibrations that are received by the diaphragm from the voice cause the electric energy on the line to increase and decrease according to the *intimacy of contact* between the vibrating diaphragm and the surface of the adjacent disk, for if the electric conductors are connected to the diaphragm and disk respectively, the current that passes will be pulsated and raised by the intimacy of contact of the surfaces or the variable resistance where the conductors are in contact with the surface of plumbago or other poor conductor of electricity." Here the resistance of the circuit is varied: by diminishing and increasing the surface of contact, by varying the path of the current outside of the area of contact, and also by varying the intimacy of contact of the electrodes. Edison testifies to this. There can be no doubt that the inertia and solidity of the second electrode assists in bringing the electrodes into more intimate contact, exactly as in Berliner's apparatus. This is anticipation as to variable pressure. Here, also, is an example of apparatus "in which the pressure is intentionally weakened in order to weaken the current," which Professor Cross says was unknown at the date of Berliner's caveat of April 14, 1877.

The patent statutes require the patentee himself to claim and define his invention so that the public may know its rights, and so that there shall not be imposed upon the courts the burden of constructing upon a hearing new claims from the interpretations that experts may place upon language of the most general and sweeping character. It is for this reason that I am of the opinion, as before stated, that the claims of this patent should be held invalid, upon the concessions of the complainant. The court should not be compelled to attempt such an impossible task as that of finding out what kind of a contact is implied in the use of the word "pressure," when all substances are capable of sustaining pressure, and when anything which can be an electrode can undergo a variable-pressure operation. Nor should the court be required to solve such problems as What kind of material is it upon which pressure "as such," can be developed? and whether the pressure upon an electrode of hard pressed plumbago is pressure "as such;" or, what is the distinction between pressure of electrodes upon each other and pressure "between" electrodes. We have here in the solid electrodes of Edison the kind of pressure called for by the Berliner patent, and the exact method of operation called for by the Berliner patent, to wit, "By making the plate vibrate, the pressure at the point of contact becomes weaker or stronger as often as vibrations occur, and the strength of the current is thereby varied accordingly;" and if the complainant's case is to stand upon abstractions which disregard essential features of the structure involved, it is very clear that the defendants have completely met the complainant's case. Claim 1 and claim 2, the *prima facie* case, and the "variable pressure" arguments, are rendered invalid by the work of Edison as exhibited in his apparatus of February 9 and April 1, 1877.

To avoid anticipation by the devices of Edison, the complainant has been obliged to abandon, practically, its variable-pressure theory; and, it seems to me, has recognized its vagueness and insufficiency and the necessity for giving a more specific description of apparatus than solid electrodes in constant contact, by developing a second theory.

We have next to consider a second generalization—the "mode of operation by varying transition resistance." Upon this the complainant seeks to identify the defendants' transmitters with that of Berliner and to avoid anticipation by Edison, and also to avoid a concession that Berliner's invention was merely an invention of apparatus. The attention is now directed to the second of the joint effects following the movement of the diaphragm, to wit, the variation of discontinuity; the weakening and strengthening of the contact.

The language of the Government Bill is quoted with approval, and is adopted by the complainant:

"The principle upon which such an apparatus operates is as follows: The discontinuity of conducting material at the point of contact between the electrodes creates a resistance to the flow of current, which resistance is increased by lightness or weakness of pressure between the electrodes, and decreased by closeness or force of such pressure. By increase of resistance in this manner the electric current flowing in the circuit is weakened, and by decrease of such resistance it is strengthened."

Professor Cross on rebuttal states the theory of transition resistance in the following language:

"When two electrodes are in contact, and a current passes from one to the other, there is a certain resistance to the passage of the current offered at the joint which is constituted by the surface of contact of the two electrodes. It is a resistance of a different character from that of the body of the electrodes themselves, and is independent in its magnitude of the resistance of the material of the electrodes. Its precise cause is not known; but it occurs only when the current passes across such a joint as I have referred to. This resistance is varied enormously by variations in pressure, and practically disappears when the pressure is other than slight or moderate. From the fact that this resistance manifests itself in the passage of the current from one electrode to the other, and that the phenomena relating to it are manifested only at the joining surface of the two electrodes when the current is in transit, as it were, from one to the other, it is very appropriately called 'transition resistance.'

Variation in transition resistance is the basis of the action of the microphone. It . . . is caused to vary by properly varying the pressure between the two electrodes in contact. That is the only mode of operating a telephone transmitter by varying transition resistance which has ever been utilized, or which, so far as has ever been shown, is experimentally practicable."

It is necessary in this case to be carefully upon our guard against confusion by verbal differences. When we wish to say that a contact changes so as to afford a greater or lesser facility to the passage of the current, we may use a different but equivalent expression and say that the resistance changes. This introduces a verbal novelty, but no real difference. The circuit is continuous when the contact is so close that, so far as the phenomena of the current are concerned, the joint behaves as if the electrodes were unbroken, and is discontinuous when less than the full amount of current passes.

Transition resistance "is always dependent upon the presence of a break or joint whereby physical continuity of the contact is interrupted to some extent," as is stated by Professor Cross. This, of course, is merely descriptive of apparatus. The extent to which this break is lessened or increased determines the action of the current. But this general language of Professor Cross's descriptive of transition resistance is applicable to the Edison apparatus of February 9, 1877. Edison's patent, applied for April 27, 1877, contains a very much better description of "transition resistance" than does the Berliner patent. We have already quoted an extract from Edison's patent that shows a resistance to the current which results from an initial adjustment of electrodes "so that in a state of rest there will be little or no current passing." Here is "loose contact" and transition resistance between solid electrodes as defined by Professor Cross. As pressure increases the initial transition resistance existing in the apparatus in a state of rest and due to discontinuity of the joint is decreased. Edison has shown a much clearer conception of the resistance due to a break or joint or loose contact than Berliner discloses in those parts of his application which were not affected by any alleged mistake of his solicitor. Berliner gives no directions that the initial current shall be less than is able to pass with full contact; the only transition resistance that he contemplates, apparently, is that put in by the vibration of the diaphragm. His transition resistance consists in weakenings of the initial contact. This was the conception shown in that part of the application which relates to weakening the current. His caveat, claim 4, described the operation of the transmitter, "vibrating the plate and diminishing the amount of electricity passing as many times and as much as the vibrations will loosen the pressure of contact." The application discloses no conception of an initial resistance that can be diminished. Counsel have quoted scientific authority for the statement "that the gist of the invention (of the microphone) seems to lie in obtaining and perfecting that which electricians have hitherto most scrupulously avoided, namely, loose contact." This of course relates to apparatus.

In fact, the evidence of experts upon the subject of transition resistance and as to the absolute necessity for a loose joint properly adjusted comes very nearly to the point of proving the insufficiency of the specification of the patent in suit. But varying transition resistance is merely varying contact. The resistance is caused by the discontinuity of conducting material or by the joint, which must be loose. To change the resistance we must change its cause—change the discontinuity; to change the discontinuity is to change the continuity, that is, to change the contact. This follows from a mere interpretation of language. The experts for the defendants prove that in all transmitters the variation of current depends upon variation of contact. Professor Anthony says: "There is no other cause of variation of the contact resistance, except variation in the area of contact or variation in the proximity or what I have called the intimacy of contact, between the particles."

Professor Cross does not deny the evidence of the defendants' experts but says: "I believe that it (the change in resistance) does depend upon the proximity of the electrodes, and so upon the proximity of the particles of these. I know of no evidence to show that it depends upon the area of the electrodes in contact. I don't know anything about the number of particles of contact, and I don't believe that anyone does. Very likely variation in the transition resistance may depend upon this, it being, as I have said before, a plausible hypothesis, though an entirely unproved one." But for the purposes of this case we are obliged to hold that the defendants have shown by a preponderance of evidence that varying transition resistance does depend upon changes in area and intimacy of contact. Upon his whole evidence Professor Cross practically concedes it. Professor Cross was asked:

"*X-Q.* In the case of two solid bodies constituting a loose joint in an electric circuit, is it your opinion that varying pressure between them does not vary the area and intimacy of contact of the two electrodes?

Ans. It is not my opinion. I believe that it does.

X-Q. Is it your opinion that such variation in intimacy and area of contact of such electrodes does not cause variations of resistance?

Ans. I believe that variation of intimacy of contact, by which I mean merely the change which takes place when the electrodes are subjected to pressure, whose character I do not pretend to determine, does produce a variation in

resistance. Whether variation in area of contact produces a sensible change or not in an ordinary microphone, I cannot say. Of course, theoretically, any change in the area of contact would be expected to produce some change in the resistance, but whether this is present to any material extent in the ordinary action of the microphone I cannot say."

Professor Cross finally says: "The actual cause of the existence and of the law of variation of the transition resistance has never been certainly proved."

Complainant's counsel and experts attempt to distinguish the prior apparatus of Edison having solid electrodes, by saying that it was Edison's intention to vary the density of the plumbago by mass compression, and to vary the area of contact as distinguished from the intimacy of contact. But no sound legal distinction can be based upon an assumed or expressed intention of Edison. The distinction must be made as to actual apparatus, and its actual manner of changing the current. Robinson on Patents, Vol. 1, Section 82; *Eames* v. *Andrews*, 122 U. S. 40, 55.

When counsel, upon the supplemental brief, say that Berliner's method is different from that of *merely* changing the surface area of contact, and from that of *merely* changing the molecular condition of one part of the circuit, they assume without sufficient warrant that Edison's apparatus did in fact so operate. They are "guessing at what occurs between the electrodes" of Edison. Both sides agree that this should not be done. Edison, before Berliner, was applying to the telephone the fact that when carbon was pressed a remarkable variation of current followed. If he did say he had discovered that plumbago had the property of changing its resistance under pressure, it does not follow that he thought that all the changes took place in the interior of the second electrode. If he thought that the instrument operated in any part by changes in the conductivity of the material of the circuit he had also conceived of cutting down the current by weakening the pressure so that a small amount of current would pass on the initial adjustment, and a greater would pass as the pressure became greater, and the contact more intimate. But more than this, he had made the instrument and described the mode of operation of the Berliner patent.

His evidence is that he employed varying "intimacy of contact" to vary the current; and his patent, applied for April 27, 1877, says so. But the complainant's experts do not avoid anticipation by Edison by limiting Berliner to transition resistance; for Professor Cross says of Edison's apparatus of the application of April 27, 1877:

"If, however, the transmitter was purposely adjusted under very light pressure, so as to operate as a microphone, which of course it can be used to do, with our present knowledge, though ineffectively, the test circuit gave evidence of microphonic action."

But Edison describes an adjustment under very light initial pressure both in his application and in his sketch of Feb. 9, 1877. Another distinction upon which the complainant seeks to avoid anticipation by Edison is the evidence of Professor Wright that there is no sensible microphonic action in the apparatus of the patent No. 474,230, of April 27, 1877; and of Professor Cross, that with that instrument so adjusted "as best to secure the cutting in and out of resistance, ... no material microphonic action need be present; and, so far as I can ascertain from careful experiment, no microphonic action is sensibly present in its operation." It is here conceded that speech can be produced by solid electrodes without microphonic action. But absence of "microphonic effect" would not save a defendant from infringing the patent in suit, and does not prevent anticipation.

The patent is not limited to electric undulations that manifest microphonic action. If affords no basis for any discrimination in respect to quality of electrical undulations.

Neither the specification nor the course of evidence in this case will permit the patent to rest upon differences that an expert ear may detect betwen undulations similar in form to sound-waves. Upon Berliner's own evidence, it is apparent that he had not reached the point of discriminating between the quality or efficiency of tones produced. There is no evidence that such microphonic effect as may be produced by Berliner's metallic electrodes is of the slightest practical importance upon a comparison of his apparatus with the prior apparatus of Edison, or that it made any advance over the magneto instrument. Berliner was not the discoverer of any improved effects demonstrated to his ear. But this distinction is of little practical importance for the further reason that "transition resistance," localized at the contact of electrodes, and microphonic action, were in the Bell mercury—plumbago transmitter.

Professor Cross says:

"If we immerse the plumbago more deeply, and exclude the immersion varying operation in this way, it is possible to transmit speech microphonically. That this is the case is shown not merely on theoretical grounds, but also by the peculiar harsh, scratchy character which characterizes a poor microphone . . . with a wire just touching the mercury surface, and particularly if the formation of a meniscus can be avoided, it is possible to transmit speech apparently by microphonic action. In this case the peculiar characteristic sounds of a poor microphone are evident." He says, "When plumbago is used with mercury, it is difficult to exclude the presence of microphonic action to a certain extent."

Professor Dunbar, defendant's expert, made experiments to show that the operativeness of the Bell mercury transmitter is not altogether dependent upon the amount of immersion of the wire, using as one electrode a conducting wire with the surface insulated except at the extreme point. He says:

"With the platinum wire insulated on its sides and presenting a conducting surface only at its submerged end, and using mercury for the liquid, speech was obtained of good articulation, although fainter than when the sides were left uninsulated."

I am of the opinion that the defendants have proven that Edison is a prior inventor of the invention of the Berliner patent, even if we assume that it bears date June 4, 1877, and rests upon the caveat of April 14, 1877; and that Edison anticipated Berliner in the construction of apparatus having constant contact, variable pressure, and varying transition resistance. But it is not at all necessary for the defendants to prove that Edison was a prior inventor. The case might well be disposed of on one short ground, to wit, the variable resistance of Edison's apparatus is an invention distinct from the variable-resistance of Berliner's apparatus, and the method of operating upon each kind of resistance is Bell's. The carbon transmitter used by the defendants is the invention of Edison, and an invention substantially distinct from that disclosed in the Berliner patent; and whether it preceded or followed Berliner's caveat or application is immaterial. The thought that the Reis apparatus might be made to perform Bell's process upon a current cannot be regarded either as a conception that was radically novel, or as an intellectual solution of the practical problem of speech transmission. According to the view of the Supreme Court, Bell taught Van der Weyde what to do in order to use a Reis instrument so as to make it transmit speech. 126 U. S. 545, 544, 542. Edison, in 1876, had this thought, but its practical inadequacy is shown by the fact that so skilled an experimenter found the Reis transmitter useless without alteration; though he was able to change the current and produce audible effects. If it has since been found that the Reis transmitter can transmit speech; if it has been discovered that such minute changes of contact as can be produced between metallic electrodes are sufficient, it is this discovery, and not the thought of making and experimenting with apparatus that is substantially the Reis apparatus, which is the substance of the invention of the Berliner patent.

The discovery of what can be accomplished with metallic electrodes is not the discovery that is utilized in the carbon speech transmitter. Edison solved the problem in another way. He says:

"I sought to devise a transmitter, or rather, an addition to the Reis telephone, which allowed me to talk low or to talk strongly, and have the same reproduced low or strongly. I felt certain that when this was accomplished speech could be transmitted and reproduced."

He found that carbon placed between the electrodes of the Reis transmitter makes it a very good transmitter. He thus dispensed with the necessity of employing such changes of contact as are used in the Berliner transmitter, and solved the problem by constructing new apparatus. Professor Brackett says:

"The introduction of carbon as one of the electrodes at once resulted in a variable-resistance transmitter which was of practical use, as is universally conceded. The reason for this result, I believe, may be found in those peculiar properties of carbon which distinguish it from other solid conducting bodies, some of which I may specify. While it is classed among the conductors, it offers greater resistance, other things being equal, than do most of the solid metals. It presents a surface which unlike the surfaces of metals, is characterized by what may be perhaps termed 'fluffiness,' by which I mean its surface presents great numbers of irregularities, so that portions of it rise above other portions, and so present innumerable prominences or elevations fitting it to readily yield to pressure applied by other solids brought in contact with it, so as to produce very great variations in what I will call the molecular area, as contradistinguished from visible area. I mean, of course, that greater variations of the numbers of molecules confronting an opposing body, which is acting upon it by variable pressure, will be produced than would be produced under like circumstances in the case of a solid metal. This property alone would mark it as especially suitable for use in a loose-contact variable-pressure transmitter. Also, the oxidation products which are liable to be formed on the passage of a current, are a gaseous character, and so will be at once removed from the surface by diffusion, thereby leaving the surface practically unchanged in character; and again, when a current of electricity passes a carbon conductor, the heat thereby produced diminishes its resistance, and so allows the current to pass more freely. These three circumstances severally and jointly tend to produce a very considerable variation of resistance to the passage of a current, and thereby make the range of action, when small differences of pressure are applied, correspondingly considerable. Possibly and likely other properties of carbon which are not well understood may conspire to produce the result in question."

Professor Wright says:

"I have spoken of the large range of carbon. By this I mean that the pressure upon the joints of the electrode may be varied within comparatively wide limits before the vibrations in the current which are produced by the pressure cease to be such as can be practically employed, in the transmission of speech. This has an important practical advantage in the fact that the adjustment of the instrument is much more easily obtained by simple mechanical arrangements than in the case of metal where this range is small.

Edison discovered that carbon alone possessed the necessary range of contact to make a practical variable-pressure transmitter. The peculiar characteristics of carbon have given carbon transmitters the entire commercial field. Edison found that the practical way of turning the Reis transmitter into a speech transmitter was not to invent a mode of operation new over Bell, but to invent the carbon electrode.

It is proved that the Bell magneto instrument is superior for practical purposes to Berliner's instruments with metallic electrodes, while the carbon transmitters are superior to the magneto instrument. The carbon transmitter could never have been found in the Berliner patent. It is not the fact that the commercial telephone was developed from a new conception disclosed to the world by the Berliner patent or caveat. Berliner's experiments and Berliner's patent conferred no knowledge as to carbon. It is not disputed that Edison's invention was developed by him independently; and it is also contended by the complainant that his invention was perfected without the conception which is said to constitute Berliner's novelty. Upon the complainant's contention, the conception of transition resistance was one that was not essential to the development of a microphone transmitter An immense amount of painstaking and highly ingenious experiment preceded Edison's successful result. The discovery of the availability of carbon was unquestionably invention; and it resulted in the "first practical success in the art." The difference between carbon and metal is a difference that has made the advance in the art.

The actual uselessness of the Berliner transmitter, the limited character of the disclosures in the Berliner specification and of the experiments and discoveries of Berliner, and the independence of Edison's invention, prevent us from treating this patent as a document which disclosed to the world an idea from which resulted a

practical success. It is conceded that the Edison transmitter as apparatus is a very important invention. All the encomiums bestowed upon Berliner are based upon what has been accomplished by Edison's carbon transmitters. It is contrary to common sense, and contrary to the spirit of the patent laws, that the work of Edison should, by virtue of after-acquired knowledge of skilled experts and by virtue of their use of the discoveries of Edison himself, be subordinated to the claims of Berliner's patent.

I think that the defendants have established the proposition stated under the fourth defence: "If Berliner had never experimented in telephony, that art in June, 1877, would have been precisely the same; and that art to-day would be precisely where it is," as the result of the work of Edison. If the Berliner patent, or the Berliner apparatus, is to be treated as a practical embodiment or disclosure of a discovery, what is this discovery? That a variation of pressure like that which was adequate in the case of liquid transmitters to produce the variation of resistance was also adequate to produce a variation of resistance between solid metallic electrodes; or that such minute changes of pressure or contact as could be produced with metallic electrodes would cause Bell's process to be practised upon the current. The patent, on its face, shows that Berliner claimed no novelty in the process performed upon the current, nor in the mode of operating upon the resistance of the circuit; that he disclaimed what counsel now claim for him—a new mode of operation. The discoveries of Berliner were so limited that upon summing up counsel for the complainant say:

"We have, then, as the result of the proofs on the part of Mr. Berliner, that he not only had an inventive conception, but that he constructed a series of instruments to embody it, and that those instruments did transmit the quality of sound, and when tested at the present time demonstrate their own effectiveness to transmit speech."

The conception, however, when reduced to definite form, resulted in apparatus that was substantially the Reis apparatus. The fact that Berliner himself constructed this apparatus is of no consequence in determining the character or scope of the conception. This amounted to no more than a thought that old apparatus might be operated by Bell's method. The discovery was that the quality of sound could be transmitted, and that he "now and then thought he could make out the words of familiar sentences, but it was exceedingly faint." According to Berliner's own testimony, this was the limit of his discovery. These are the only microphonic facts that he discovered. The microphone was not the result of a conception, but of a discovery of facts. Berliner did not discover, nor did he state the principle of the microphone; for, according to the evidence of the complainant, this principle is unknown, and according to the evidence of the defendants it is Bell's principle of variable contact produced by the pressure of sound waves. The discovery that any new or improved effect upon the current would result was not made by Berliner. As a discoverer of microphonic facts, he made no practical advance upon Reis (126 U. S. 540, 541); and added little or nothing to what Edison had learned as to the capacity of the Reis apparatus. As a "conceiver," he conceived only what Edison had conceived and tried with similar results before him. Berliner did not conceive that solid electrodes would produce an effect such as was afterwards distinguished as a microphonic effect, and he did not discover any difference from the magneto transmitter in the effects on the current.

Edison, by independent investigation, made discoveries of very great importance as to the effects produced with different materials in different adjustments, and made over the Reis transmitter into a practical speech transmitter. The subsequent or previous discovery that the old Reis transmitter could be made to perform the operation may be of scientific interest, but upon no principle of common sense can it be made to control and anticipate the solution of the practical problem by Edison's different experimental method.

The utmost that Berliner can be entitled to is apparatus substantially like that disclosed in his patent, when used for the transmission of speech. So hopeless is the complainant's case, if Berliner's invention is to be considered merely an invention of apparatus for practising Bell's method, that the complainant persistently ignores all comparisons of Edison's and Berliner's transmitters in respect to practical utility, and insists that the test of infringement is comparison as to a method or process involved in the apparatus. It is clearly shown by the defendants that the Berliner patent does not disclose, and that Berliner did not invent, a new art or process.

Upon what is the Berliner process or art practised? Not upon the current; not upon the resistance of the circuit; for this is all disclaimed and is Bell's. Leaving out manufactures and compositions of matter, the patent law provides no middle ground between patents for an art and for a machine. Berliner's invention of a "new mode of operation" seems to be neither an art nor a machine, but an abstraction which may be described, in the language of Chief Justice Fuller, as "a disembodied shape in an intermediate state of ambiguous existence." See *Westinghouse* v. *Boyden Power Brake Co.*, 170 U. S. 555, 556. Having first in the patent and in the *prima facie* case claimed broadly the method of Bell's patent when practised between opposing electrodes, and every form of constant-contact transmitter that it is possible to make, the complainant seeks to save its broad generalization by excepting from it various kinds of apparatus that come within its terms; but, after all these exceptions are made, the complainant's claims still have a scope to which they are not entitled. The generalization can be corrected only by the admission that the method of operation is Bell's method, and that it does not constitute a new method to construct a new kind of circuit or to make a new kind of variable resistance.

As a matter of fact, the complainant's case on rebuttal shows a substantial departure from the contention that Berliner did invent a new art, process or method, and actually rests upon the proposition that the Berliner patent is to be construed as claiming and covering all telephonic apparatus having transition resistance. The new distinction introduced by the expert evidence as to transition resistance is an implied limitation as to apparatus. First claiming broadly all electrodes; then, by arbitrary exception not found in the terms of the claims, limiting itself to solids to avoid Bell's liquid transmitter; it now limits the apparatus to electrodes having transition resistance in order to avoid Edison's solid electrodes. We should remember that the fundamental proposition of the complainant, upon which learned and astute counsel have deliberately based this very important case, is that Berliner's invention does not reside in the structure involved,—"not in mere parts of metal or other conducting material so placed in an electric circuit as to serve as electrodes, but in a mode of operation whereby the sound-waves, by varying the pressure between these electrodes, vary the contact or joint between them." Transition resistance, however, does reside in the structure involved; and it is perfectly manifest that, assuming the existence of apparatus having transition resistance, the method of varying that resistance is the same as for varying any other kind of resistance, to wit, the method of Bell's patent, claim 4,—gradually increasing it and diminishing it by sound-waves.

Counsel say that the words "electric speaking telephone transmitter operated by sound-waves" obviously bring in the mode of operation and the force which operates. This is an exposure of a fundamental fallacy in complainant's case, to wit, the claim that the making of a new kind of circuit or a new form of resistance makes a new method or art that includes a novel relation of sound-waves to this new kind of resistance. Bell's art covers resistance of any kind, and only the new thing upon which his method of claim 4 is to be practiced is patentable after Bell. There is no shadow of invention in the use of the minute force of a sound-wave to effect changes in a circuit after Bell and Edison. There is no shadow of invention in using sound-waves upon an instrument for the transmission of sound, after Bell. Sound-waves as the motive force, and electrical undulations conforming thereto, were factors in the problem given by Bell. Bell's patent covers sound-waves brought into a new relation with an electric current, and also into relation with the resistance of a circuit, whatever its kind.

The complainant could not stand for a moment upon the proposition that Berliner made any new discovery as to the force that a sound-wave can exert upon a circuit. The only scope for invention, after Bell, is in the apparatus employed to obey his law. The vibrations of a diaphragm under the sound-waves involve no novel elemental action not previously in Bell and Edison. The patent disclaims novelty in the process practiced upon the current. The form of undulations, not their character, is all that is claimed. It was a known fact that the Reis apparatus could control the electrodes so as to strengthen and weaken the contact; that the vibrations of a diaphragm were of sufficient force to accomplish all that Berliner described in his application; that is, to weaken the initial contact of electrodes down to the breaking point. In the Reis musical transmitter, as well as in Bell's liquid transmitter, was shown all that Berliner needed to learn as to the power of sound-waves.

Some confusion has arisen from the fact that it is proven that the Reis apparatus, or Berliner's, is like a tool which, at the pleasure of the operator, may be made to perform the breaking operation of Reis or the variable-pressure operation of Berliner. The operator may turn the screws so that the contact will be broken, or so that it will be preserved, or he may drop his voice in order to preserve contact; but the patent covers no art or skill required to keep electrodes in constant contact, or if it does is not infringed in this respect. The "method" of claim 1, and which "characterizes" the instrument of claim 2, requires, as a condition precedent, electrodes in constant contact. Professor Cross says, "Constancy of contact will not transmit speech;" and that the variable-pressure operation is impossible when there is no contact. If there is an art or method of preserving the contact of electrodes which, in view of the experience of Edison and Berliner, and the evidence of experts as to experiments with metal electrodes, seems not improbable, it is not the method or art set forth in claim 1, and should not be confused with it. The method is "by causing the sound-waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact." The patent sets forth, as the only means of securing constant contact, a screw. The "causing" is accomplished by placing the apparatus where there are sound-waves. This is a very different thing from Mr. Bell's "causing electrical undulations" as a method of transmitting sound, or of causing the resistance of a circuit to vary in accordance with sound-waves. Berliner's solicitor has not succeeded in paralleling Bell's claim 5. The production or selection of sound-waves is no part of a new art or process. When the exhibitor of the apparatus speaks, he is merely producing sound-waves, which is no part of the method of causing them to produce electrical undulations of similar form. If he drops his voice so that it will be a weak force, he is merely producing sound-waves appropriate to the particular form of apparatus. If he finds a weak voice coming through the air, that will answer. Dropping the voice to feeble tones is an equivalent to a

turn of the screw which is set forth in the patent as the means of preserving the contact.

No new art or method can be practised in front of the diaphragm. Berliner's mode of operation cannot be brought in upon the sound-waves. It is all determined by the structure of the instrument. If the art is to be practised at the diaphragm, or if it is to be practised in putting a suitable amount of transition resistance into the circuit, the patent is certainly bad, since it leaves this art or method to be discovered by experiment. Professor Brackett truly says, "So far as the method of operation is concerned, there is no novelty over Bell." There is also no novelty in mode of operation over Edison, even assuming that there is a novelty in the kind of resistance operated upon. The fact is that the complainant's fundamental proposition that Berliner's invention resides in a new mode of operation is erroneous. Berliner's invention, assuming that he made one, does reside in and is limited by the structure involved; and amounts simply to a discovery of the capacity of a specific structure to obey Bell's law.

Berliner was not the first to introduce transition resistance into a circuit. The complainant concedes that Berliner was not the first to make the apparatus which it terms a microphone. The Reis apparatus is conceded to be a microphone, and to have such transition resistance that it is capable of transmitting speech. Reis's failure was due to the fact that, in operating his machine, he put in so much transition resistance that he interrupted his current. It is unjust to these defendants that this case should be tried upon the theory of transition resistance, or upon the German patent to Ludtge; but I am of the opinion that, even if Berliner's claims are to be interpreted in the light of expert evidence as covering all transmitters having transition resistance between electrodes, these claims are of excessive breadth, and go far beyond the scope of any conception or discovery of Berliner. If Berliner discovered that such transition resistance as existed ready to his hand in the Reis transmitter was capable of varying the current, this gave him no right to claim any and all apparatus having transition resistance. As he does not describe it, gives no specific directions as to the amount necessary, gives no evidence that he made any investigations in consequence of a conception of this character, his utmost claim to transition resistance is to such as was involved in the structure which he used, to wit, such transition resistance as is possessed by metal electrodes when properly adjusted. Professor Cross says, of the granules of the powder form transmitter: "The carbon employed is of such a character as to possess a high transition resistance at the contact points." The complainant cannot monopolize a resistance "possessed" by carbon.

It follows that the Berliner patent, if it is valid at all and discloses an invention, is nevertheless so limited that it does not include the defendants' devices. Claim 1 for a method is invalid. Counsel justly say of this claim, "We have claimed as a method the operation of the apparatus exhibited; nothing more."

Counsel for defendants contend rightly, I think, that the so-called "method" is mere phraseology, and merely an indirect description of apparatus. They say, "Why could not Mr. Hunnings have said, 'I claim the method of producing undulations in a circuit by causing the sound-waves to vary the pressure upon the flexible wall of a cell containing carbon powder included within the circuit, and thereby increase and diminish the resistance of the circuit?" If, after Bell, the Berliner method claim is good, every inventor of a new form of transmitter may base upon the peculiar features of his apparatus a new method claim for a process involved in the operation of his apparatus.

Berliner did not alter Bell's variable-resistance method by applying it to the Reis electrodes, which the Supreme Court said Bell had taught Van der Weyde how to use, and might himself have used instead of the apparatus which he adopted. 126 U. S. 540. *Westinghouse* v. *Boyden Power Brake Co.*, 170 U. S. 537, 554-557. Like the method of the patent, the mode of operation by variable pressure and the mode of operation by varying transition resistance are merely indirect and abstract descriptions of a part of what occurs in the operation of particular apparatus. We may test the identity of meaning conveyed by these various expressions by giving a Reis apparatus to three practical electricians; by telling the first to operate it according to Bell's method; the second, according to the variable-pressure method; and the third, according to the varying transition resistance method. If these persons are sufficiently intelligent to comprehend what is meant by these instructions, each will do exactly the same thing. If this cannot be done without further invention, then it seems that the Berliner patent is invalid for an insufficient specification.

It is furthermore important to observe that no method was claimed until 1880, after two years' public use. For this reason alone, claim 1 is invalid. The patent, therefore, must stand, if at all, upon claim 2. Taken literally, it is anticipated by the Bell mercury transmitter, and by Edison's devices of Feb. 9 and April 1. The patent confines itself to metal for the pin or second electrode, and carbon was disclaimed. Construed from the specification, the disclaimer of carbon and the experience of the patentee, as detailed in his testimony, it covers only its described electrodes and their known equivalents. Carbon was not a known equivalent. This claim cannot cover all solid electrodes, because, after Bell's invention, the problem was not to find a new method, but to discover a better material than Bell's mercury electrode. The claim cannot cover all solid material, for solidity of contacting surface is not in and of itself enough to make an apparatus practical or commercial.

In *Edison Electric Light Co.* v. *United States Electric Lighting Co.*, 52 Fed. Rep. 308, it was said:

"The degree of difference between carbons that lasted one hour and carbons that lasted hundreds of hours seems to have been precisely the difference between failure and success, and the combination which first achieved the result 'long desired, sometimes sought and never before attained,' is a patentable invention."

The decision of the Supreme Court in The Incandescent Lamp Patent, 159 U. S. 465, 476, is exactly in point. There is was said:

"Under these circumstances, to hold that one, who had discovered that a certain fibrous or textile material answered the required purpose, should obtain the right to exclude everybody from the whole domain of fibrous and textile materials, and thereby shut out any further efforts to discover a better specimen of that class than the patentee had employed, would be an unwarranted extension of his monopoly, and operate rather to discourage than to promote invention."

In that case the patent was held void. Fibrous or textile material was "too indefinite to be the subject of a valid monopoly."

In the present case, we have not even an equal limitation, for claim 2 does not mention solid material for the electrodes, but simply electrodes in constant contact—language broad enough to include various transmitters which are acknowledged not to be within the scope of Berliner's invention.

I am, therefore, of the opinion, that even if the complainant were able to prove that Berliner had in fact made an invention; that his application upon its face disclosed this invention; that he was lawfully entitled to make the amendments; and that his previous patent of 1880 did not exhaust the power of the Commissioner to grant the patent in suit, and that he was not anticipated by Edison; that, even after all this, well-established rules of law would require us to hold that claim 1 of this patent is void, and that claim 2 is either void or so limited that it does not include the defendants' transmitters.

It has been impossible, in this opinion, to consider all the points of the very able arguments that have been presented, or all the important contentions that have arisen. The brief of the defendants has met the case of the complainant thoroughly and completely, and with very exceptional ability and commendable fairness has demonstrated, in my opinion, that the complainant's case rests upon a patent that should not have been granted, and which is void for error apparent upon the face of the records of the Patent Office; that as a matter of fact Berliner on June 4, 1877, the date of his application, had not made the discovery that speech could be transmitted with the apparatus of the patent in suit, and was at that time, and long after, like other unsuccessful experimenters, attempting to use a broken current. In addition to the fundamental defects in the complainant's title to the patent, it appears that the best argument that skilled experts and learned and ingenious counsel can base upon this patent is logically untenable and legally unsound.

The bills will be dismissed.

General News.

THE TELEPHONE.

SIDNEY, O.—The Sidney Telephone Company has been incorporated to build a local exchange. Capital stock, $10,000.

ELMWOOD PLACE, O.—The village council has granted a franchise to the City & Suburban Telephone Company of Cincinnati to build a local exchange connecting with the city.

NORTH LEWISBURG, O.—The North Lewisburg Telephone Company has been organized by local people to build exchanges in this place and in Lewisburg. Franchises have been secured in both villages.

NAPOLEON, O.—The Napoleon Home Telephone Company has been incorporated by James S. Brailey, James S. Brailey, Jr., H. A. Barber, Clive Chandey and W. C. Fink. Capital stock, $50,000. The company will maintain an exchange in Napoleon, with toll lines in Henry, Fulton, Defiance, Ottawa and Wood counties.

MARION, O.—The Marion County Telephone Company has abandoned hope of securing a franchise from the council and will apply to the Probate Court for a grant. The company has organized with the following officers: F. E. Guthery, president; C. H. Norris, vice-president; O. Wollenweber, treasurer, and French Crow, secretary.

THE ELECTRIC RAILWAY.

SAN FRANCISCO, CAL.—A route is being surveyed for an electric railroad from the Bully Hill mine, near Delamar, Cal., to a connection with the Southern Pacific Railroad near Kennettoo. The Shasta Electric Power Company is expected to supply power for the operation of the road this winter.

DANBURY, CONN.—Surveys for the electric railroad between Danbury, Conn., and Golden's Bridge, N. Y., have been completed, contracts have been awarded, and construction will shortly begin. The road will be about seventeen miles long, through a rich farming territory and several villages, and it is believed that the road, which is to be completed by September 1, will bring considerable trade to Danbury. The Danbury and Golden's Bridge Street Railway Company, which is to own and operate the road, was chartered in Connecticut in 1897.

COLUMBUS, GA.—The Drake & Stratton Company has sold its controlling interest in the Columbus Railroad Company, which embraces the electric lighting service here, to George J. Baldwin, of Savannah, and his associates, Messrs. Stone and Webster, of Boston, for $225,000. Fifty thousand dollars will be spent immediately on improvements.

MILFORD, MASS.—The Hopedale selectmen have voted to grant the Worcester & Milford Street Railway Company a location, one-fourth of a mile long, on the main road between Milford and Upton.

LENOX, MASS.—The Pittsfield Electric Railway Company wished to extend its lines to Lenox, and petitioned the General Court at Boston for certain rights. Influence was brought to bear, and the petition was withdrawn. Another electric railway company, the Berkshire, appeared in the field. During last winter the project began to be talked about of a trolley line to reach the entire length of the county, connecting the central towns. Nearly all the towns applied to have granted franchises. The Berkshire Electric Railway is thus an assured institution. It met with violent opposition in Stockbridge, because it insisted upon laying its rails in the main village street, one of the most beautiful streets in all New England. But the company failed in its attempt to secure legislative enactment, and will have to take whatever route the people of Stockbridge elect to give. As soon as the franchises from that town and Lanesboro are granted, the railway will be built. This road will enter Lenox on the extreme east, with a spur track up to the village.

SEDALIA, MO.—The Railway & Electric Company has been incorporated; capital, $250,000. Incorporators: W. B. Broomall, L. A. Duhring, Lewis Davis, W. S. Shirk and others.

WOODBURY, N. J.—A deal has been consummated by which the Gloucester and Salem Turnpike Company was merged into a trolley company, and a line is to be built from Woodbury to Swedesboro, and also connect with the Paulsboro Traction Company's line at Clarksboro. The directors of the new company are William H. Sayen, Barker Gummere, Jr., W. S. Hancock, of Trenton; J. J. Summerill, Charles W. Knight, of this city, and James J. Davidson and A. A. Bradshaw, of Swedesboro.

WATERTOWN, N. Y.—The Watertown & Carthage Traction Company has been incorporated with a capital of $200,000 to build and operate a trolley line between Watertown and Carthage.

ALBANY, N. Y.—The Mohawk River Traction Company has been incorporated, with a capital of $160,000. The road will be 16 miles long and situated in Montgomery and Schoharie counties.

CANASTOTA, N. Y.—The Canastota & Morrisville Railway has been incorporated to build and maintain a surface road, to be operated by electricity, 15 miles long, in Madison County. Capital stock, $200,000.

NEW YORK, N. Y.—Beginning July 1, letter carriers in Brooklyn, wearing their uniforms and carrying their bags, may ride on the cars of the Brooklyn Rapid Transit Company without paying. The Government will pay a lump sum of $9,000 a year for the privilege.

NEW YORK CITY.—There is a widespread belief that electricity has about driven the horse out of the horse-car business in this city, with the exception, of course, of the few short crosstown lines down town. An officer of the Metropolitan Street Railway Company states that the company had about 6000 horses employed on its system. Not all of these were used in drawing cars.

NEW YORK, N. Y.—The Long Island Extension Railroad Company, which was incorporated at Albany last week, to construct and operate an underground tunnel from the Long Island Railroad property in the Borough of Queens under the East River to Manhattan, has been formally organized. Samuel Rea, fourth vice-president of the Pennsylvania Railroad and a director of the American Exchange National Bank, was elected president, and F. E. Haff was chosen secretary and treasurer.

ROCHESTER, N. Y.—The Monroe County Electric Belt Line Company is projecting a trolley road to connect with Rochester. It will run through Brighton, Fairport, Penfield, Pittsford and Despatch. It will be incorporated for $250,000. Among the incorporators are George W. Albridge, Merton E. Lewis, A. H. Bown, W. W. Bown, J. Breck Perkins, C. J. Brown, W. H. Rowerdink, D. C. Becker, P. R. McPhail, W. A. Parce, George K. Higbie, C. W. McKay, C. H. Judson, Ira M. Luddington and A. J. Grant.

TROY, N. Y.—The New York State Board of Railroad Commissioners gave a hearing last week on the application of the Troy, Rensselaer & Pittsfield Railroad Company, to operate an electric line between Rensselaer, Troy and Pittsfield, Mass. The application was opposed by the United Traction Company of Albany, the Boston & Albany Railroad, the New York Central Railroad and the Chatham & Lebanon Springs Railroad Company. The application was opposed on the grounds that the road would parallel the roads of the other companies. No decision was given.

LONG ISLAND, N. Y.—The Hempstead-Mineola & Freeport Traction Company, having obtained a franchise from the trustees of the village of Hempstead to build a trolley line in the village streets, has been given a franchise by the Nassau County Board of Supervisors permitting the use of certain county roads for a trolley line. This franchise will enable the company to extend its line from Hempstead village to this place over the costly macadamized highways. The company has also been voted a franchise in Freeport by the property owners. The village trustees there would not assume the authority to grant the franchise, so it was put to a vote, and carried by 7 to 1. The company is said to be backed by capitalists of Cleveland, Ohio, and it is promised that the work of building the new lines will begin during the present summer. Ten cents will be the fare between Freeport and Hempstead and five cents between Hempstead and this village.

PORT CHESTER, N. Y.—The State Railroad Commission met last week to consider the application of the New York & Port Chester Railroad Company for permission to construct and operate a railroad. The route the new company desires to cover is from 132d Street to the State line in Port Chester, through the towns of Rye, Harrison, Mamaroneck, New Rochelle and Mount Vernon. The opposition to the desired franchise included, for the Union Railroad Company, W. H. Page, Jr.; for the New York, New Haven & Hartford, H. W. Taff; for the New York City & Westchester, John McDonald; for the New York Central, W. Waller, and for the Port Chester & Larchmont line, F. W. Sherman. H. A. Gambleton, of the North Side Board of Trade, John E. Persons, for himself, and George Crawford, for the Crawford Real Estate Company, also entered formal appearance. Mr. Page objected to the manner of advertisement of the applicant company, and the Commission sustained his objection. Notice of the Port Chester Company's application was published in the *Law Journal*, and David Murray, of counsel for the road, contended that was sufficient publication. The Commission was unanimous in disagreeing with him.

HILLSBORO, O.—The Chillicothe-Hillsboro Traction Company has secured a franchise from the town of Hillsboro for its line on several streets and for furnishing light in the town.

DAYTON, O.—The Dayton & Germantown Traction Company has increased its capital stock from $450,000 to $500,000, and has amended its charter to permit the extension of the road from Germantown to Middletown.

LISBON, OHIO.—The Salem, Lisbon & East Liverpool Traction Company, of Lisbon, capital stock $10,000, has been incorporated by H. Whitford Jones, Fred W. Holt, Charles H. Taylor, George H. Billman and H. H. Poppleton.

JEFFERSON, O.—The Burton, Jefferson & Andover Electric Railway Company has organized as follows: Officers: President, Eugene Rowdon; vice-president, W. H. Dodge; secretary, S. L. Osborn; treasurer, C. E. Meigs.

WARREN, OHIO.—The Cleveland & Eastern Electric Railway Company has applied for a fifty-year franchise from the Trumbull county line, near Phalanx mills, to Leavittsburg. The company will probably come from Leavittsburg to Warren over private right of way.

TOLEDO, OHIO.—Negotiations are under way for the consolidation of the Toledo & Monroe Railway Company and the Toledo, Bowling Green and Southern Traction Company. The former is owned by a Detroit syndicate and the latter by George B. Kerper and others, of Cincinnati. This would complete a line from Toledo to Findlay, a distance of 64 miles. It is said that as soon as the consolidation is effected the line will be built into Detroit from Monroe.

GETTYSBURG, PA.—The Baltimore, Westminster & Gettysburg Electric Railway Company has secured control of the Baltimore pike from Reiterstown, 19 miles north of Baltimore, to a point near Chambersburg, Pa.

READING, PA.—The United Traction Company, of Reading, having secured control of the Neversink Mountain Railway, has elected these officers of that road: President, Walter A. Rigg; Secretary and Treasurer, T. W. Grooket; Directors, J. Milton Miller, Samuel E. Rigg, J. H. Bucher, W. A. Rosen and K. A. Fichthorn.

NORTH AUGUSTA, S. C.—The North Augusta Electric and Improvement Company has applied for a charter to construct an electric line from Hamburg to Aiken.

CHARLESTON, W. VA.—The West Fork Construction Company has been incorporated, to construct street railroads, etc. Capital, $250,000.

MANCHESTER, VA.—Since Judge Hancock has refused to enjoin the erection of a new electric railway from Manchester to Petersburg, the work is being pushed to completion.

GRAND RAPIDS, WIS.—D. O. Fisher, of this city, has petitioned the council for a franchise to build an electric railway here. It is to be part of the proposed electric railway from Stevens Point to Nekoosa.

General News.

THE TELEPHONE.

STOCKTON, CAL.—The Sunset Telephone Company has started work on a new line from this city to Fresno. The wire will be an aluminum cable of seven strands. The company has just completed a new line from San Diego, through Los Angeles to Bakersfield and repaired the system between the latter town and Fresno. By constructing a new line from here to Fresno a direct system will be opened.

SAN FRANCISCO, CAL.—Another attempt is being made to provide San Francisco with an independent telephone system. M. Adrian King has petitioned the supervisors, through his attorney, for a franchise granting him the privilege of laying conduits for telephone and telegraph use. Accompanying the petition for a fifty-year franchise was a draft of an ordinance providing that the city shall have free use of fifty telephones and shall share the use of poles and conduits of the new concern. Also, that the company shall have at least 5,000 telephones in use within three years from date of franchise and shall install switchboard and conduits for a capacity of 15,000 subscribers. Two per cent. of the gross receipts are to go to the city. It is said that Mr. King represents St. Louis capitalists, whose ultimate purpose is to establish a local and long distance telephone system to cover the Pacific coast. The same people have filed a request for a telephone franchise in Los Angeles, Cal.

DENVER, COLO.—The Western Slope Telephone Company will build 45 miles of new line to connect Leadville with its line at Wolcott. The Western Slope company now has lines connecting with the Colorado company's lines at Rifle and extending to Hahn's Peak, Steamboat Springs, Milner, Hayden, and remote sections of Routt county which has heretofore been without communication with the outside world except by mail. The company recently completed 100 miles of new line.

NEW BRITAIN, CONN.—The stock of the Farmington Valley Telephone Company of New Britain has been increased from $3,500 to $7,000.

WILMINGTON, DEL.—The Delmarvia Telephone Company contemplates resuming the work of building the extension from this city to Perryville, Md., where connection is to be made to Baltimore.

WASHINGTON, D. C.—The State Department is in receipt of interesting information concerning work on the British Pacific telegraph cable, which is to connect the Dominion of Canada with the Australian confederation. The new cable is to be 5834½ miles in length—the longest ever constructed—and will be transported and laid by one ship, which is now being built for that purpose. Consul Abraham Smith at Victoria, B. C., informs the State Department that a surveying party has located the landing site at the Canadian end of the cable, at a point on Kelp Bay, near Banfield creek. It is about seven miles from the entrance to Barclay Sound, and something over one hundred miles from Victoria. The location is reported as being admirably adapted for that purpose. The cable will run from Vancouver island to Fanning Island, which lies south of Hawaii—a distance of 3337 miles—before a landing is effected. Thence it is laid to the Fijis, to Norfolk Island and thence to Queensland.

ATLANTA, GA.—The Southern Telephone and Telegraph Company may erect a large addition to its telephone exchange. W. T. Gentry is superintendent of construction. The new addition will probably cost $20,000.

ATLANTA, GA.—A new and complete system of Bell telephones will soon be in operation at Anstell, connecting that city with Atlanta, in addition to Mableton, Lithia and other local stations. J. P. Woodson, an electrical engineer from Atlanta, will construct the line immediately and it is expected to be in operation at an early date. There will be about 25 subscribers to begin with.

OSKALOOSA, IA.—The Home Telephone Company has been succeeded by the Oskaloosa Home Telephone Company.

MAXWELL, IOWA.—Maxwell has a local telephone company with seventy instruments connected with the Independence lines.

LITERBERRY, ILL.—The Liter Arcadia Telephone Company, of Literberry, has increased its capital stock from $1,500 to $5,500.

ELIZABETH, ILL.—The Jo Daviess County Mutual Telephone Company of Elizabeth has been incorporated; capital stock, $2,500; incorporators, William Skine, Ernest Stadel and Rudolph Dittmer.

CHICAGO.—Miss May Schultz, who contends that she has been permanently injured by a telephone receiver, has filed suit in the Superior Court against the Chicago Telephone Company for $30,000 damages. While she held a receiver to her ear on April 23, 1899, an unusually strong electrical current is said to have come over the wire. The force of the shock is said to have thrown the girl from her chair to the floor. Her face became black, and now retains a red tint on the left side. Several weeks ago an operation was performed on the injured left ear, and it is said that it showed that the bones on that side of the face were dead.

INDIANAPOLIS, IND.—The Millville Telephone Company, of Millville, has been incorporated; capital stock, $3,000. Directors: John J. Allen, Will. Wisehart, Joseph Bird, James A. Stafford, Martin Wood.

NASHVILLE, IND.—A local company is now constructing the first telephone exchange this town has ever had. It was only a few months ago that this town was entirely shut off from communication with the outside world, but since then a telephone line has placed the people in connection with several points in the State.

INDIANAPOLIS, IND.—The following telephone companies filed articles of incorporation with the Secretary of State during the past week: The Waveland Telephone Company, capital stock, $1,000; the Shannondale Co-operative Telephone Company, capital stock, $1,600; the Millville Telephone Company, capital stock, $3,000, and the Farmers' Mutual Telephone Company, of Hancock County.

WEST NEWTON, IND.—Farmers in this neighborhood and the adjoining valley mills neighborhood have constructed private telephone lines to their homes and are now preparing to connect them with an exchange that is to be established at West Newton by the New Telephone Company. The subscribers own their wires and poles, and pay the company 50 cents a month each for the connection. The plan is to establish the service on farms all over the county.

INDIANAPOLIS, IND.—Mr. S. P. Sheerin, vice-president and manager of the New Telephone Company, contends that the country telephone line (and all other telephone lines which go along the country road) should be considered as part and parcel of the road itself. They should not be considered as tenants of the road, or as something that is there by sufferance, or by the permission—grudgingly given—of those who, for the time, do not appreciate its advantages, but it should be regarded as a part of the road itself. He said that the independent movement gives opportunity for self helpfulness and intellectual coöperation. That which a man can do for himself is most likely to be quickest done. The flexibility of the independent plan is its greatest recommendation.

BALTIMORE, MD.—Mayor Hayes has sent a letter to the heads of all departments under the city government notifying them that the city has entered into a contract with the Maryland Telephone Company for all municipal telephone service, which is to be in charge of Mr. Charles E. Phelps, Jr., engineer of the Electrical Commission. They are instructed to notify the Chesapeake & Potomac Telephone Company to remove its instruments.

BALTIMORE, MD.—The Maryland Telephone & Telegraph Company, of Baltimore, is securing rights of way in several towns of Cecil County to erect its line. The company proposes to erect a trunk line through the county, connecting the Baltimore system with a Wilmington telephone company.

HUDSON, MICH.—The Rollin Telephone Company has completed arrangements to extend its line to Hudson. The line will then connect with Rollin, Geneva, Manitou Beach and Addison. An effort is being made to extend the system all over southern Michigan. It is a farmer's system.

ST. PAUL, MINN.—The Fulda Telephone Company of Murray County, with headquarters at Fulda, has been incorporated. The residents of that village are the incorporators. The capital stock is $25,000. The Iron Range Telephone Company has increased its capital stock from $50,000 to $75,000.

BOONVILLE, MO.—A telephone line is being built to connect this city with Chouteau Springs.

KANSAS CITY, MO.—The public sale of the Standard Telephone Company's line by Clarence S. Palmer, receiver, brought $6,400. The majority stock of the Russell Telephone Company was sold to E. J. Douglass for $500. The Central Missouri Telephone Company, with 400 miles of line, was sold to J. A. Lander, of Yoakum, Texas., for $1,400.

ECONOMY, MO.—The Union Telephone Company has filed articles of incorporation. The capital stock is $1,000. The company already has seven different lines in operation of about 80 miles each. The headquarters are at Economy, and from there the company has an independent line running to each of the following named places: Macon, Atlanta, La Plata, Ten Mile, Nichelton, Redman and Sue City.

BUTTE, MONT.—The Rocky Mountain Bell Telephone Company filed its annual statement. It shows the capital stock of the company to be $1,222,200, all paid up; total assets, $1,674,926.73, of which $75,768.66 is in cash and $189,046.63 in real estate.

SOUTH OMAHA, NEB.—The Bradshaw Telephone Company, Bradshaw, Neb., has been incorporated; capital, $50,000. Incorporators: Daniel Graves, W. A. Wells, L. S. Loomis and others. The company will build an exchange and territorial lines at once. The Albion, Neb., Telephone Company has incorporated; capital, $20,000. Incorporators: A. Harris, President, S. F. Martin, secretary. This company will build an exchange and territorial lines.

RALEIGH, N. C.—The Board of Aldermen has granted a franchise to the Southern Bell Telephone Company to construct conduits for underground telephone wires within a prescribed limit.

NEW YORK CITY.—The telephone girls of the New York Bell Telephone Company are all being vaccinated.

ELMIRA, N. Y.—The Elmira Telephone Company has filed with the Secretary of State a certificate of increase of capital stock from $40,000 to $150,000.

NEW YORK, N. Y.—The Postal Telegraph Cable Company of New Jersey has been incorporated to operate the Postal Company's lines in New Jersey; capital stock, $50,000.

RICHFIELD SPRINGS, N. Y.—The Richfield Springs Telephone Company has been incorporated. Capital, $5,000. Directors, M. A. McKee, John Gyer and F. E. Munger, all of Richfield Springs.

ALBANY, N. Y.—The Wharton Valley Telephone Company, of South Edmeston, Otsego County, has been incorporated; capital, $3,000. Directors: B. F. Bishop, of Garrattsville; Van Ness D. Robinson, of Edmeston, and Frank Harrington, of West Burlington.

NAPOLEON, O.—The City Council has granted a franchise to the Citizens Mutual Telephone Company.

PAULDING, O.—The Paulding Home Telephone Company has amended its charter to permit it to build toll lines through Scott, Hicksville, Ottawa, Cecil, Tipton, Grover Hill, Bryan and Defiance. John S. Snook, A. N. Wilcox and O. K. Dickinson are the owners.

YOUNGSTOWN, OHIO.—Owsley & Boucherle, local architects, are preparing plans for a large office building for the Dollar Savings & Trust Company. An electric light plant will be installed. The upper floors of the building will be utilized by the Youngstown Telephone Company for its new exchange.

FINDLAY, OHIO.—The Home Telephone Company exchange has opened for business with about five hundred telephones in operation. The others of the total list of one thousand will be connected as fast as possible. The formal opening of the plant will be fittingly celebrated in a few weeks and be made quite a gala occasion.

COLUMBUS, O.—Representatives of the Bell Telephone Company have presented to the State Board of Appraisers, under the Nichols law, a request that in cases in which telephone operating companies rent their instruments the taxes on the telephones be assessed against the companies that control the instruments under the lease. Under a recent decision of the Supreme Court such instruments have been taxed against the owning company at a value determined by their earning capacity. The Nichols law provides that local companies shall pay taxes on all lines owned by them or leased.

CLEVELAND, O.—At the annual meeting of the Cleveland Telephone Company (Bell) directors were elected as follows: Philip Dexter, Reginald Foster, Chas. J. Glidden, Thomas Sherwin, of Boston; Frank F. Hickox, Lee McBride, A. B. Hough, William J. McKinney, J. P. McKinstry and E. P. Wright, of Cleveland. The directors organized by electing Chas. J. Glidden, president; J. P. McKinstry and H. J. Pettengil, vice-presidents; George B. Perham, secretary; Walter Abbott, treasurer; P. Yensen, general manager. Executive committee, Philip Dexter, Thomas Sherwin, Reginald Foster.

TOLEDO, O.—Failing to get satisfaction out of the City Council, the Toledo Home Telephone Company has appealed to the Probate Court for a franchise to build its system in Toledo. The company offers a rate of $44 per year for business telephones and $26 for residences, and agrees to have its system in operation with 3,000 subscribers by December 31, 1903, work to begin within 60 days. Free telephones will be placed in all city departments and the company proposes to furnish two $10,000 surety bonds to guarantee the fulfillment of the contract. The company is promoted by Frank Graves and E. F. Seabolt.

WAXAHACHIE, TEX.—Representatives of an independent telephone company have filed an application with the City council for a franchise for the establishment of a new telephone system here.

LAKE CREEK, TEX.—The Southern Telephone Company of Lake Creek, Delta County, filed an amendment to its charter providing for an increase of its capital stock to $8,000.

CLEBURNE, TEXAS.—The Southwestern Telegraph and Telephone Company is building from its central office here a rural line to connect Bono, George Creek, Nemo, Wilson's Park and Mimm's ranch with the city by wire.

TEXARKANA, TEXAS.—The city council on the Texas side granted to S. F. Richardson and associates a franchise to build and operate a local and long distance telephone exchange for a period of thirty years. The city already has one such system, operated by the Southwestern Telegraph & Telephone Company.

SALT LAKE CITY, UTAH.—The Bell Telephone Company will build a line between Nephi and Tintic. The company has opened exchanges at Twin Bridges, Mont., where eighteen subscribers have been secured, and at Miles City, where there are seventy subscribers.

MILWAUKEE, WIS.—The Kurtz National Telephone Company, has been incorporated with a capital stock of $25,000.

MILWAUKEE, WIS.—The Common Council has recommended the passage of an ordinance compelling all telephone and telegraph companies to place their wires underground in streets having permanent pavement.

ELECTRIC LIGHT AND POWER.

BIRMINGHAM, ALA.—Arrangements have been made for the consolidation of the Birmingham Railway, Light & Power Company, the Consolidated Electric Light Company and the Birmingham Gas Company. The capital stock of the new company will be $10,000,000. Isadore Newman, of New Orleans, Harry M. Atkinson, of Atlanta, and others effected the deal.

SAN FRANCISCO, CAL.—The new contract for lighting the public buildings of San Francisco was recently awarded to the Independent Electric Light & Power Company.

GAINESVILLE, GA.—A $100,000 company has been projected to develop the Chattahoochee River. Hon. Samuel C. Dunlap and F. S. Murray, of Chicago, are the principal promoters. The company will be known as the Gainesville Light and Power Company.

LA SALLE, ILL.—The Enterprise Heat, Light and Power Company, of La Salle, has been incorporated; capital stock, $25,000; incorporators, William B. Hummer, George A. Wilson and Timothy Lucey.

CARROLLTON, ILL.—The City Council and the Carrollton Electric Light and Power Company have failed to agree upon the terms of a new contract for street lighting, and as a result the city is likely to be in darkness within a few weeks. The present contract for street lighting and operating the water works plant expires July 7, and the bid of the Coal Company for service in the future was accepted by the council some weeks since. The company wants a thirty-year franchise and the council insists on a five-year franchise. Unless some agreement is reached before July 7 the lights and water will probably be shut off.

MONTICELLO, IND.—The Monticello electric light plant has changed owners, the Thorp brothers selling to A. T. Barnes and George A. Harris, of Antwerp, O., the consideration being $22,000.

CAMBRIDGE CITY, IND.—This city has tried municipal ownership and operation of electric lights for over a month, with most satisfactory results. There were in use during May thirty-seven arc lights and 500 commercial incandescents, and these, it is stated, cost much less than the old company charged for half night service.

BALTIMORE, MD.—Negotiations, it is said, are pending between the Consolidated Gas Company and the United Electric & Power Company, looking to a consolidation or joint ownership. The matter was held up pending an adjustment of the affairs of the Susquehanna Power Company, which is also involved.

PARIS, MO.—Contracts will be let on August 1 for the construction of a water and light plant at Paris, Mo.

ST. LOUIS, MO.—There is a rumor in circulation to the effect that some Cincinnati capitalists are trying to buy the Imperial and Missouri Edison Electric Light Companies, with a view of ultimate consolidation with the Laclede Gas Light Company and Citizens Lighting Company.

ST. LOUIS, MO.—The Imperial Electric Light, Heat & Power Company has asked for permission of the City Council to extend its system beyond its underground plant under the provisions of its original franchise. The reason for asking this additional privilege is thought to be a desire on the part of the company to be able to reach the World's Fair grounds, which its present franchise will not allow.

ST. LOUIS, MO.—The fluctuations in the cost of city lighting in the last ten years are exhibited in the annual report of supervisor of lighting, submitted a few days ago. The cost of lighting streets, alleys and public places was $416,080.95 last year, $94,169.54 in excess of 1899-1900, and $107,312.38 in excess of 1889-90. The cost of lighting public buildings was $95,799.49 last year, $22,908.18 in excess of the previous year and $63,285.37 in excess of 1889-90. The annual cost of street lighting was as follows: 1889-90, $308,768.57; 1891, $206,156.53; 1892, $213,525.76; 1893, $223,500.02; 1894, $239,005.63; 1895, $254,809.31; 1896, $269,986.36; 1897, $267,157.45; 1898, $305,877.97; 1899, $320,029.13; 1900, $321,911.41; 1901, $416,080.95. The cost for lighting public buildings was as follows: 1890, $32,514.12; 1891, $46,204.12; 1892, $44,186.45; 1893, $45,792.82; 1894, $48,305.79; 1895, $51,910. 05; 1896, $58,120.80; 1898, $63,532.60; 1897, $66,992.04; 1900, $72,891.31; 1901, $95,799.49. For lighting public buildings the Missouri-Edison Electric Company receives 13 cents per 1000 watt-hours, and the Laclede Power Company 12 cents.

DULUTH, MINN.—The Zenith City Electric Company and the Richardson Electric Company, Duluth, Minn., have been consolidated.

NIOBRARA, NEB.—The plant of the Niobrara Electric Light Company has been sold to Randa & Gruenberg.

FAYETTEVILLE, N. C.—The Fayetteville Ice Company has made a proposition to the town to furnish a building and power for fifty arc electric lights. Dr. J. W. McNeill, chairman of the electric light committee, recommends that thirty arc lights be used on the streets and that twenty be sold. He also asks for an expert to examine into the cost of installing the dynamos.

BAY HEAD, N. J.—Mayor Pennington, William Packer, member of the Borough Council, and George Nunimaker, a prominent citizen, were arrested on June 22 and held in bonds to keep the peace. With the Mayor at their head and armed with an axe they made an assault on the poles and wires of the Point Pleasant Electric Light and Power Company, and were chopping away energetically when the hand of the law was laid upon them. This is the climax of a war that has been raging for a week between the Greenville Arms Hotel and the electric light company on the one hand and the Mayor and the Common Council of Bay Head on the other, there being opposition to the hotel, etc., on the part of the residents.

WATKINS, N. Y.—The Watkins Consolidated Electric and Gas Light Company of Watkins has been formed. Capital, $100,000. Directors, A. R. Horn, of Catasauqua, Pa.; J. J. McKee, of Bethlehem, Pa., and Charles B. Reid, of New York city.

TARRYTOWN, N. Y.—The Hudson River Gas and Electric Company, of Tarrytown, has been formed. Directors, A. M. Young, H. G. Runkle, B. W. Stillwell, W. W. Sorugham, F. A. Stratton, G. W. Curran, C. H. Werher, R. A. C. Smith, W. F. Sheehan, Walter Clark and Lewis Lillie.

DOYLESTOWN, O.—Chas. F. Sturtevant, a Chicago engineer, is to prepare plans for a municipal lighting plant for this place.

HURON, O.—The mismanagement of Huron municipal affairs has made it almost impossible to pay the bonds on the municipal lighting plant, and the plant may be sold.

MARYSVILLE, O.—The village council has voted to employ an expert to examine the private lighting plant in this place, with a view to purchasing it for a municipal plant.

HUBBARD, O.—At a recent special election the citizens of this place voted to issue bonds to the amount of $8,000 to rebuild the municipal lighting plant, which was destroyed by fire some time ago.

SANDUSKY, O.—The Sandusky Gas & Electric Light Company has submitted a proposition for city lighting, as follows: Ten-year contract, all night schedule, $80; five-year contract, $85. The city is now paying $87.50. A resolution has been presented to the council to build a municipal lighting plant.

TIFFIN, O.—The Consolidated Gas & Light Company has been incorporated by M. B. Dailey, R. W. Kirley, C. F. N. Niles, of Toledo; J. M. Barr, of Findlay, and W. H Dore, of Tiffin. Capital stock, $500,000. The company has absorbed the gas property owned by the Kerlin Brothers Company, the Tiffin Electric Light Company, and the Tiffin Light & Fuel Company. It is stated that $500,000 was paid for the properties. Coons, Barr & Co., Cleveland bankers, are financing the project.

HAMILTON, ONT.—The Cataract Power Company, of Hamilton, has concluded negotiations with the Dundas Electric Light Company and will take over the business and rights of that company.

OTTAWA, ONT.—A proposal is made to transmit electric power from Nottawasaga River to the town of Stayner, Ont., six miles distant. The scheme would give enough power to induce manufactories to locate in that vicinity.

CHARLESTON, W. VA.—A company composed of West Virginia capitalists has been formed for the purpose of buying and operating under one management the Charleston (W. Va.) water works, the Charleston Electric Light & Power Company, the Charleston Gas Company and the Charleston Traction Company.

WAUSAU, WIS.—The plant of the Wausau Electric Company was damaged by fire on June 18 to the amount of $1,000.

THE ELECTRIC RAILWAY.

BIRMINGHAM, ALA.—A deal consolidating the Birmingham Railway, Light & Power Company, the Consolidated Electric Light Company and the Birmingham Gas Company, arranged by Isadore Newman, of New Orleans; Harry M. Atkinson, of Atlanta, and the Old Colony Trust Company, of Boston, has been completed. The new corporation will have a capital of $10,000,000.

HARTFORD, CONN.—It is officially announced that when the through trolley line between Hartford and Springfield is completed, the running time between the two cities will be an hour and a half, and the fare 30 cents. The distance is about 30 miles.

NEW HAVEN, CONN.—It is reported that the Connecticut Railway & Lighting Company, which is controlled by the United Gas Improvement Company of Philadelphia, has just closed a deal by which it secures control of the entire electric railroad system of New Haven. It is said that the price paid was $3,000,000. Mr. A. M. Young, of Waterbury, Conn., is the moving spirit in the Connecticut Railway & Lighting Company. The company controls about half the entire trolley mileage in Connecticut.

DOVER, DEL.—The United Railway, Light and Charter Company, with a capitalization of $5,000,000, was incorporated. The company is authorized to purchase and acquire land and buildings for operating railways and heat, light and power plants.

ATLANTA, GA.—It is said that the electric railway between Atlanta and Marietta, Ga., is again being talked of and that right of way has been secured.

COLUMBUS, GA.—Geo. J. Baldwin, of Savannah, Ga., and Boston parties have secured a controlling interest in the Columbus Railroad Company, embracing electric and dummy lines and the electric power and lighting service. About $250,000 was represented by the deal.

SPRINGFIELD, ILL.—Articles of incorporation have been issued to the Cairo, Memphis & Southern Railroad Traction Company, with headquarters at Chicago. Capital stock, $40,000. The incorporators are Herman Paepche, C. Fred Yegge and W. B. Beckman.

CHICAGO, ILL.—The American Railways Company, incorporated in New Jersey, will build an elevated line in this city from Seventy-first Street to the Loop and will be a competitor of "Alley L." It will also absorb the Desplaines Valley and Blue Island Electric surface lines for feeders.

INDIANAPOLIS, IND.—A group of New York capitalists is considering the construction of a trolley road 100 miles long running through the centre of the Wabash Valley in Indiana. Options have been secured for all the necessary right of way. The proposed route runs through or very near to some of the most populous towns and cities, and it is predicted the road will prove very profitable. There is little competition in view.

CHICAGO, ILL.—Mr. George F. Harding has told the Chicago council committee on local transportation that the city has the right to buy the present street railway lines under the terms of the ordinance of 1858. He offers to pay all legal expenses if the city decides to buy out the companies' property. The proposition is novel to the committee. All its members believe in municipal ownership, but they have never taken up the question whether such ownership has been provided for in an ancient ordinance. Mr. Harding's offer has been referred to the sub-committee on franchises and ordinances. There is authority for the statement that the city will demand permanent compensation for street car franchises and will not accept a lump sum.

ANDERSON, IND.—The Merchants' Association to-day decided to build an electric railway from this city to Middletown, nine miles distant.

INDIANAPOLIS, IND.—An interurban franchise has been agreed upon by the Board of Public Works and the interurban roads now entering this city.

ANDERSON, IND.—The Union Traction Company, of this place, has sold its old power house plant at Marion, Ind. to a company that will build electric railways radiating from Richmond, Ind.

INDIANAPOLIS, IND.—The craze to secure electric railway franchises over public highways has ceased in this State. The reason is capitalists will not finance a road unless it secures a private right of way.

INDIANAPOLIS, IND.—The Central Traction Company, of this city, incorporated to build a line from here to Richmond, has changed its name to the Indianapolis & Eastern Traction Company. A company previously organized had taken the same name.

MUNCIE, IND.—The Union Traction Company announces that it will make a further reduction of fare to compete with the Big Four Interurban trains and the reduced fares on the same. The competition between electric and steam roads is growing bitter and the rates have already been cut in two.

ROAN, IND.—A monster railroad meeting was held here recently. The crowd that gathered listened to an address and arguments of Wabash business men in favor of voting a subsidy of $10,000 to build the Rochester-Wabash interurban road. The aggregate amount of subsidies asked along the entire route is $100,000.

LOUISVILLE, KY.—The Louisville Railway Company will on July 1 increase the wages of its 350 motormen and conductors from 17½ cents to 18½ cents an hour.

MAYSVILLE, KY.—The Maysville & Mt. Olivet telephone line has been sold to the company represented by Col. Jas. W. Chambers, superintendent of the Maysville system, and Dr. Edwin Matthews. Important improvements are being made.

LAPEER, MICH.—The village board of Imlay City, and the township board of Imlay township, have granted franchises to the Detroit, Utica & Romeo Railway for an electric road.

NEW YORK, N. Y.—Owing to the recent crippling of two of the electric power houses and the opening of the Manhattan and Brighton Beach lines, the Brooklyn Rapid Transit Company has found it necessary to temporarily discontinue the third rail system on some of the elevated lines and return to the use of steam. This will afford a more effective trolley service on the surface roads.

ALBANY, N. Y.—The Cortland County Traction Company was incorporated with a capital stock of $320,000. It has purchased the property and will operate the franchises of the Cortland & Homer Traction Company. The directors are C. D. Simpson, William B. Wait, of New York City; Frank Battles and George H. Fisher, of Philadelphia; Herman Bergholtz, of Ithaca; H. P. Simpson, of Scranton, Pa.; G. H. Garrison, of Troy, and B. T. Taylor, Edwin Duffy and E. H. Brewer, of Cortland.

NORWALK, OHIO.—The Norwalk, Ashland & Southern Railroad Company has applied for a franchise to enter the center of Norwalk.

CANTON, OHIO.—The council has granted a franchise to the Akron-Canton Railway Company enabling it to enter the center of the city.

CHILLICOTHE, OHIO.—The Chillicothe & Hillsboro Traction Company has applied for a franchise enabling it to enter the center of Chillicothe.

PIQUA, OHIO.—The Miami Valley Railway Company has been granted a franchise to extend its road. The company may furnish light and power along the extension.

OTTAWA, OHIO.—The city council has granted a franchise to the Defiance, Ottawa, Kenton & Columbus Traction Company. The road must be completed by December 31, 1903.

CINCINNATI, O.—M. J. Mandelbaum, of Cleveland, denies that he is making an endeavor to secure, through the electric railway franchise, a new route for cars along the canal bank.

DEFIANCE, OHIO.—Citizens of Evansport have made a proposition to the Northern Ohio Electric Railway Company to locate its power house in that village. Defiance also wants the power house.

AKRON, OHIO.—The Summit County commissioners have granted a franchise to T. L. Childs for a road from Akron to Cleveland. He is supposed to be backed by the Haserot Brothers of Cleveland.

CINCINNATI, O.—The Board of Public Service of this city has approved the ordinance authorizing the Cincinnati & Northwestern Railway Company to change its motive power from steam to electricity.

CINCINNATI, OHIO.—The Elkins-Widener syndicate, which owns the Cincinnati Traction Company's lines, has practically closed a deal for the purchase of the Cincinnati, Covington & Newport Street Railway Company.

URBANA, OHIO.—The Dayton, Springfield & Urbana Railway Company was unable to place its line through the northern section of this place, in operation at the time required by its franchise, and in order to hold the grant an ancient horse car is now being operated.

GALION, OHIO.—The Ohio Central Traction Company will extend its lines to Crestline, five miles north. The Mansfield, Crestline & Galion railway has secured a franchise between the two cities and proposes to build a line which will be part of the link to connect Cleveland and Columbus by an electric road.

CLEVELAND, OHIO.—The Cleveland syndicate, which has recently secured control of the Aurora, Elgin & Carpenterville Electric Railway, has placed a contract with Rossiter, McGovern & Company, New York, for 65 equipments of No. 68, 40-hp Westinghouse motors to entirely replace the present car equipment of the road.

TOLEDO, O.—The Consolidated Gas & Light Company has acquired the properties of the Kerlin Brothers Company, the Tiffin Light & Fuel Company, and the Tiffin Electric Light & Gas Company, at Tiffin, O., for $500,000. The new company is headed by M. B. Daly and C. F. M. Niles, of Toledo, and J. M. Barr, of Findlay.

ZANESVILLE, OHIO.—The Muskingum county commissioners have granted franchises to the following companies: Zanesville Electric Railway Company, Newark, Zanesville & Coshocton Traction Company, the Black Diamond Traction Company and Black & Taylor. The franchises are all for twenty-five years and work must commence by Jan. 1, 1902.

CLEVELAND, OHIO.—The Everett-Moore syndicate has consolidated the Detroit & Toledo Shore Line Company with the Toledo & Detroit Shore Line Company. The deal involves $800,000. The consolidation includes all the trackage, rolling stock, right of way and other equipment of the first named company between Toledo, Ohio, and Monroe, Mich.

CINCINNATI, OHIO.—It is stated that John G. Kilgour, formerly president of the Cincinnati Street Railway Company, is at the head of a company to be known as the Ohio Valley Interurban Railway Company, which will build a line following the Ohio River Valley from Cincinnati to Portsmouth, touching many towns not at present accessible by railway.

CLEVELAND, OHIO.—The Cleveland, Wadsworth & Southern Railway Company has been incorporated with $10,000 temporary capital stock by E. A. Akers, G. D. Hile, C. S. Horner, F. G. Anthony and W. H. Hill. It proposes to build a line from Cleveland to West Lebanon, Wayne County, with branches from Grange to Akron and from Dalton to Massillon.

CLEVELAND, OHIO.—The Columbus & Southern Railway Company has formally notified the Scioto Valley Traction Company, which is promoted by Cleveland people, that it has decided to withdraw from the field in the matter of building a road from Columbus to Circleville and Chillicothe, right of way over this route having been contested for some time by both companies.

CLEVELAND, OHIO.—The Xenia & Wilmington Traction Company has been incorporated by John P. Martin, Charles Orr, Eckstein Case, C. J. Dockstader, H. M. Yost and William E. Sage, of Cleveland. The company will build a line from Xenia to Wilmington, touching several good towns. It will be a part of the Southern Ohio system, which is owned by the Pomeroy-Mandelbaum syndicate of this city.

LIMA, OHIO.—The recently incorporated Lima, Lewiston & Bellefontaine Railroad Company has organized as follows: Directors, W. W. Fisher, C. D. Campbell, W. C. Huston, E. M. Hamilton, of Bellefontaine; W. P. Heston and Elias Barthomew, Toledo; A. F. McCormick, Columbus; Carl Wells, X. H.

Holler and S. M. Finch, of Lima; President, W. W. Fisher; Vice-President, W. P. Heston; Secretary, X. H. Holler; Treasurer, J. M. Boose; General Manager, H. F. McCormick; Assistant General Manager, Elias Bartholomew.

PHILADELPHIA.—Following up his offer of $2,500,000 for the new franchises, Mr. John Wanamaker has now offered $500,000 bonus to the owners of them as well, and has promised to charge 3 cent fares between 5 and 8 a. m. and 5 and 7 p. m.

CLEARFIELD, PA.—The Bituminous Street Railway Company of Clearfield, capital $180,000, has been chartered by the State Department to construct a line with 30 miles of track connecting Clearfield with Dubois Falls Creek and other thickly populated districts in Clearfield County.

HARRISBURG, PA.—The Sharon & New Castle Railway Company has been incorporated; capital, $500,000. The company will operate a railway between Sharon and New Castle, Pa. The incorporators are William W. Wherry, Jr., Leighton Calkins and K. K. McLaren, all of No. 15 Exchange Place, Jersey City.

RICHMOND, VA.—After months of contention a new era has been inaugurated in street railway traffic at Richmond, Va., by which the local railway companies will operate on certain streets on one another's tracks, each company having secured the privileges for which they have contended.

RICHMOND, VA.—The Lincoln Park Company, composed of W. B. Hoover, president; S. R. Reeve, secretary and treasurer, and other Newport News, Va., gentlemen, has been granted a charter; capital $50,000. Among the privileges enumerated are those of erecting street car and electric light systms.

CHARLOTTE, W. VA.—Representatives of a large Eastern syndicate are working on the details of consolidation of the electric light, street railway and water works plants into one system. Lines of the street railway will be extended into the Kanawha Valley in several directions. New equipment for the street car company is to be purchased.

GRAND RAPIDS, WIS.—D. O. Fisher, of this city, has petitioned the council for an electric railway franchise.

KAUKAUNA, WIS.—The Wisconsin Traction, Light, Heat & Power Company has been granted a franchise to build an electric railway in this city. This is an extension of the interurban line built two years ago from Neenah to Appleton.

EAU CLAIRE, WIS.—Arthur E. Appleyard, owner of the Dayton, Springfield & Urbana (O.) electric railway system, has made some preliminary surveys here with a view of incorporating a company to build an electric railway from Eau Claire to St. Paul.

SHEBOYGAN, WIS.—Senator Eaton, of Milwaukee, one of the incorporators of the Waukesha-Milwaukee electric interurban line, is reported to be at work on a plan for an electric interurban line to pass through this city and to connect Milwaukee and Green Bay.

MENOMINEE, WIS.—T. T. Frawley and D. Douglas, of Eau Claire, Wis., representing a syndicate, have offered to buy the Menominee street railway system. The same parties wish to purchase the Marinette street railway system and to build an interurban electric road between the two cities.

TWO RIVERS, WIS.—The village of Mishicott has granted Thomas Higgins a franchise to build an electric railway. This completes the last step toward securing the right of way between Two Rivers and Kewaunee. The building of the road north to Kewaunee is an important step to the peninsula cities, whose only outlet thus far has been by way of Green Bay. In all probability the road will be extended to Algoma and Sturgeon Bay.

MILWAUKEE, WIS.—The last link in the chain of electric railways to connect Milwaukee and Chicago has been arranged. The Chicago, Kenosha and Milwaukee Electric Railway Company has made a contract with the Kenosha Street Railway Company by which the new company will have the right to run its cars over the lines of the Kenosha Company. The line is now complete, from both Chicago and Milwaukee, as far as the city limits of Kenosha.

THE AUTOMOBILE.

ELECTRIC VEHICLE FOR FIRE DEPARTMENT CHIEF.—The Electric Vehicle Company has been awarded the contract to supply an electric vehicle for the use of Chief Sullivan, of the San Francisco Fire Department.

GREENSBORO, N. C.—It is stated that arrangements have been completed for the establishment of an automobile line in Greensboro. R. Dulaney Whiting, of New York, who visited this section last year, is interested. It is expected that the line will be in operation by August 1.

NEW INDUSTRIAL COMPANIES.

THE NEW JERSEY POWER STORAGE COMPANY has been incorporated with a capital stock of $100,000.

LIBBY TURBINE COMPANY, of Wilmington, has been formed to make and deal in water wheels and mill machinery. Capital, $250,000.

RANDALL ELECTRIC COMPANY, of New York City, has been formed. Capital, $10,000. Directors, P. M. Randall, N. E. Randall and J. G. Gorham, New York City.

THE GREENSBORO ELECTRIC COMPANY, Greensboro, N. C., has filed articles of incorporation with an authorized capital of $250,000. M. D. Barr and others are interested.

THE MALTBY AUTOMOBILE AND MANUFACTURING COMPANY, of Brooklyn, has been formed. Capital, $20,000. Directors, I. S. Cormer, F. E. Phillips, and C. C. Protheroo, of New York city.

PALMER & OLSEN, of New York City, have been incorporated to deal in electric vehicles and machinery. Capital, $20,000. Directors, C. A. Olson and H. B. Palmer, New York City; C. E. Francis, Brooklyn.

SPENCER ELECTRICAL COMPANY, of New York City, has been formed. Capital, $100,000. Directors, J. H. Spencer, of New York City; C. L. Child, of Montclair, N. J., and Henry Dawson, of Richmond Hill, L. I.

THE MANHATTAN CONSTRUCTION COMPANY, Cleveland, O., has been incorporated by Clement McMahon, Jr., S. B. Newman, Samuel Morris, S. A. Fallen and Chas. T. McKissen. The company will build steam and electric railways.

THE WHEELER-GREEN ELECTRIC COMPANY has been formed in Rochester, N. Y., to do a general contracting, jobbing and repairing business. The members of the firm are Clarence Wheeler, Thos. Green and Whiting J. Da Lee. Their place of business is at 22 North Water Street.

NEW DYNAMO MANUFACTURING COMPANY.—A company to make dynamos and motors will be incorporated at Milwaukee, by L. Federman, A. Ecke, C. Siebert and E. Kileber, former employees of the Allis-Chalmers Company. The capital stock will be about $50,000 and the parties are now looking for a site for the factory.

LEGAL.

DISSOLUTION.—The Electrical Engineering & Supply Company, Charlotte, N. C., has entered an application to the Secretary of the State for the dissolution of the company. The officers of the company are: Dr. I. W. Faison, president; S. J. Smith, vice-president, and D. S. Yates, secretary and treasurer.

PERPETUAL FRANCHISE.—At Nashville, Tenn., Chancellor Cook has decided that the Nashville Railroad has a perpetual ownership in the streets of Nashville. Suits were instituted to obtain a revocation of the charter of the integral lines, on the ground that the consent of the city to a transfer of franchises had never been obtained as required by law. The Chancellor held that the consent of the city was not essential.

KINLOCH COMPANY'S SWITCHBOARD.—The United States Circuit Court at St. Louis, Mo., last week granted an order restraining the Kinloch Telephone Company from using the switchboard which is installed in its exchange. The telephone company is allowed thirty days in which to comply with the order. It is claimed by the complainants that the defendant company infringes on a patent switchboard controlled by the Western Electric Company and invented by John A. Seely.

PEORIA ELECTROLYSIS CASE.—In the well-known case between the Peoria Waterworks Company and the local Central Railway Company, the special master in chancery has decided in favor of the waterworks, to the effect that the trolley system with rail return has injured the water system and that the defendant ought to put in the double trolley, or some equivalent system of "completely insulated metallic circuit." The master concedes that the street railway company has done all that is possible in the present state of the art, but holds that an injunction should issue. This decision, as it stands, may be fraught with serious consequences to various trolley systems throughout the country.

TELEPHONE LIGHTNING ARRESTER.—The Circuit Court of the United States for the Eastern Division of the Eastern District of Missouri has handed down a decision against the Kinloch Telephone Company, of St. Louis, Mo., in a suit of the Western Electric Company for infringement of a patent granted October 21, 1890, to Anthony C. White for a telephone lightning and high polential current arrester. The points at issue were the use of a dielectric between roughened carbon plates, one of the plates having embedded a plug of easily conducting material. The alleged infringed device is described by the Court as similar to that of the plaintiff, with the exception that in it the carbon plates are held apart by a silk dielectric which is not slotted, and instead of the alloy plug of the White arrester each of the defendants' carbon plates contains, in a conical recess, a lead pellet or shot, held in place by a small quantity of beeswax. The opposing surfaces of the plates are not specially roughened, but are as smooth as the ordinary process of manufacturing permits. The use of the fusible substance in carbon plates is held to be an infringement, but not the use of carbon plates in themselves, if not roughened.

ELECTRIC RAILWAY STOCK.—An important decision has been handed down by Judge Phillips in Cleveland in one of the cases which has been hanging fire for several years bearing on the consolidation of several lines in that city into the Cleveland City Railway Company. At the time several of the lines, including the cable road, were consolidated in 1893, the cable company had a floating indebtedness of $421,621. The capital stock of the company was $4,000,000. According to the consolidation agreement, 18,250 shares of Cleveland City Railway stock were allotted to the holders of the cable stock and they were to pay their pro rata share of the floating indebtedness of the company. The new stock was turned over to J. J. Shipard and Frank De Hass Robinson, to be distributed, but a large share of it failed to reach the persons to whom it belonged because of the defalcation of J. J. Shipard. Those who failed to secure their stock brought suit against the Cleveland City Railway Company. This was the first of the cases, the amount involved being $10,000. The various cases aggregate over $500,000. The company lost every point. Judge Phillips held that the company was bound to see that the stock was issued and applied in faithful discharge of the trust. He held that Shipard and Robinson acted as agents for the company and were responsible to the company. He ordered the company to pay Fuller 20 per cent dividends upon the stock, dividends to that amount having been declared by the company since the suit was brought, and to turn over the full amount of stock or its value. The company will appeal the case.

OBITUARY.

MR. C. H. ROLLINS, an engineering student, graduate of the Maine State University, was killed by shock on June 22 at the Lynn General Electric Works, by accidental contact with wires from a bank of high voltage transformers.

MR. G. VAN GINKLE, recently president and chief owner of the Electric Street Railway, Dallas, Tex., was run over by one of the cars of that road on June 21 and killed instantly.

PERSONAL.

L. W. STANTON.

MR. L. W. STANTON, whose paper on exchange work, read at the recent Independent Telephone Convention, was one of the features and attracted much attention, is, as his portrait shows, still a young man, but has had a wide experience in electrical and telephone engineering. Receiving a thorough technical education, he has supplemented this with practical experience in almost every phase of electrical work. His first training was in an electrical supply store, in which he owned a half interest. After the expiration of the Bell Telephone patents in 1893 he assisted in the construction of one of the first independent telephone exchanges in the country, at Cambridge, O., and attended several of the meetings held at Columbus, O., by the pioneer independent telephone men. After completing the plant at Cambridge, he accepted a position to construct and manage the exchange at Barnesville, Ohio. Thence he went to St. Louis, Mo., secured a position with the local Bell Telephone Company, and worked in several departments during the construction of their fine new common battery plant, his aim being to become acquainted with every class of telephone engineering. After the completion of this plant he spent a few months with the National Conduit and Cable Company, surveying for and installing the conduit system for the Electric Light & Power Companies of St. Louis. He then became connected with the Standard Underground Cable Company while they were completing cable work for the Kinloch Telephone Company, and upon the arrival of the Kellogg Switchboard & Supply Company, helped to install the switchboard for the Kinloch Telephone Company. After the completion of this work he was sent by the Kellogg Company to Cleveland, O., to install the board for the Cuyahoga Telephone Company, which is said to be the largest board in the country. After completing this work he accepted the technical position which he still holds with the Federal Telephone Company, which controls a number of exchanges in Ohio, besides the U. S. long distance lines.

MR. THOMAS J. JOHNSTON, the patent lawyer, has removed his offices to 66 Broadway, New York city.

MR. ARTHUR WILLIAMS, of the New York Edison Company, sailed last week on the Oceanic for a European trip of some weeks.

COL. JAS. L. TAYLOR has resigned as third vice-president of the Consolidated Railway, Electric Lighting & Equipment Company, of this city, to engage in other work.

DR. K. AUER VON WELSBACH has been made a baron by the Emperor of Austria in recognition of his various remarkable inventions and contributions to science. He is only 42 years of age.

MR. A. V. ABBOTT, E. E., since resigning from the engineering staff of the Chicago Telephone Company, has been making a trip through the East visiting many old friends and various electrical plants.

DR. HENRY PRITCHETT, president of the Massachusetts Institute of Technology, has been appointed superintendent of awards at the Pan-American Exposition and will have the selection of all the juries of awards.

DR. LIONEL FLEISCHMANN, of the Union Elektricitacts Gesellschaft, of Berlin, who has been visiting this country again, and has made a long stay at the General Electric Schnectady shops, sailed for Germany this week.

MOODY-BAKER.—Vice-President W. H. Baker, of the Postal Telegraph Cable Company, and Mrs. Baker announce the marriage, on June 18, in Brooklyn, of their daughter, Miss Ethel Chandler Baker, to Mr. Harry Le Roy Moody.

MR. F. P. FISH, who is said to be making a flying trip to Europe, was duly elected president of the American Telephone & Telegraph Company at the meeting of the directors in Boston on June 19. His election, announced some time ago, takes effect on July 1.

MR. GRENVILLE A. HARRIS, formerly construction engineer with the Westinghouse Electric and Manufacturing Company, and now with the exporting firm of Takata & Company, of New York, was married on June 27 to Miss Blanche Sheffer, of Baltimore, Md.

CONGRESSMAN ROBERT H. FOERDERER, who may become head of the proposed new street railway company in Philadelphia, has, it is said, pledged himself to secure 3 cent fares provided that it can be demonstrated that dividends can be earned with fares at that low figure.

MR. B. KILGOUR.—The employes of the Cincinnati Street Railway Company recently presented to Mr. Bayard Kilgour, ex-president, a handsome oak desk, as a mark of their appreciation. Mr. Kilgour recently severed his connection with the company to go with a telephone company.

MR. JAMES BOYD, well known on the New York Stock Exchange as a leading specialist, and who has been identified with the Western Union, was the recipient, last week, of many attentions on his 70th birthday. He received floral congratulations and other marks of esteem from his broker colleagues.

MR. W. V. B. VAN DYCK, instructor in electrical science at Rutgers College, has tendered his resignation to the Board of Trustees. He is interested in an electrical company in New York city, and leaves Rutgers so as to be able to more fully look after his duties here. Mr. Van Dyck is a son of Prof. F. C. Van Dyck, of Rutgers.

MR. THOMAS I. STACEY, secretary and treasurer of the Electric Appliance Company, of Chicago, has been visiting Philadelphia, and has been entertained by Messrs. Charles M. and E. Ward Wilkins, of Partrick, Carter & Wilkins. Mr. Stacey returns to the West with a very pleasant recollection of Philadelphia, as Messrs. Wilkins Brothers are noted for their cordiality for entertaining strangers. Mr. Stacey was accompanied by his wife.

MR. F. BATHURST, of the Conduit and Insulation Company, Ltd., of London, is now on a trip to this country with his wife. He has not been in good health, and proposes to combine recreation with business while here. Mr. Bathurst spent some years in this country as an electrical engineer and has long been one of the foremost advocates in England of conduits for interior wiring. Much of the best work has been done under his supervision.

MR. NELSON PERIN.—It is officially announced that Nelson Perin, president of the United Railways & Electric Company, Baltimore, will retire at the next meeting of the directors, and will be succeeded by George R. Webb, who is also president of the Maryland Telephone Company. It is also asserted that Mr. Perin's holdings in the company, amounting to about 25,000 shares of stock, have been sold to a syndicate headed by Alex. Brown & Company, who financed the present combination.

MR. CECIL B. SMITH, Mem. Can. Soc. C. E., assistant engineer, City Engineer's Department, Toronto, Canada, and formerly assistant professor of civil engineering, McGill University, and Mr. Wm. S. Aldrich, Mem. Am. Inst. E. E., Mem. Am. Soc. M. E., Professor of Electrical Engineering, University of Illinois, have opened an office as consulting engineers, rooms 101-103, Mail and Empire Building, Toronto, Canada. As Prof. Aldrich has practiced and taught both mechanical and electrical engineering, and Prof. Smith has done notable work in civil engineering, the new firm is peculiarly well equipped for both general and special engineering practice.

POPE-RUSSELL.—The marriage was celebrated at Great Barrington, Mass. on June 12, of Franklin Judson Pope, son of Mr. R. W. Pope, the worthy secretary of the American Institute of Electrical Engineers, to Miss Mary E. Russell, daughter of Mr. and Mrs. P. A. Russell. The wedding ceremony took place at the Congregational Church and was largely attended, while the gifts were numerous and handsome, including one from Governor Crane of Massachusetts, of whose council the bride's father was recently a member. Another came from the bridegroom's associates on the editorial staff of the New York *Evening Sun*. The wedding was followed by an electric light fête at the residence of the bride's parents.

Trade Notes.

THE GOLD CAR HEATING COMPANY, New York, has recently equipped fifty cars of the Brooklyn elevated with its electric heaters. These cars will also be fitted out with the Gold gate locks.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is manufacturer of the Eaco visual signal switchboard, which it claims has all of the advantages of the flashlight board and without the aggravations caused by the burning out of the signal lamps.

SMITH & HEMENWAY COMPANY and the Utica Drop Forge & Tool Company have an exhibit in the Maryland collective exhibit, section S, Electricity Building, Pan-American Exposition. Printed matter and catalogues will be distributed by the Smith & Hemenway people.

THE C. C. CHESNEY CONTRIBUTION to "Lightning Protection," which appeared in the columns of the ELECTRICAL WORLD AND ENGINEER June 1, has been issued in pamphlet form. Copies will be mailed gratis upon request to Mr. Ray D. Lillibridge, 20 Broad Street, New York City.

MACHINE TOOLS.—In a neat pamphlet, the Becker-Brainard Milling Machine Company, Hyde Park, Mass., illustrates and describes its exhibit at the Pan-American Exposition. This kind of advertising literature is a pronounced improvement over the usual method of distributing general catalogues to those viewing an exhibit.

THE CENTRAL ELECTRIC COMPANY, of Chicago, is in a position to make immediate shipments of large and small orders for telephone construction material. The Central is carrying large quantities of cross-arms, pins, brackets, insulators, telephone wires, etc., in Chicago stock in order to be able to make immediate shipment of this material.

DIAMOND PROSPECTING DRILL.—The M. C. Bullock Mfg. Company devote the latest of their catalogues (No. 46) to a detailed description of the Bullock "Diamond" drill, which is described and illustrated in all of its forms. Several views show the drill at work, one being a photographic reproduction representing a South African drilling plant.

MICA.—The Chicago Mica Company, Valparaiso, Ind., devotes a four-page sheet to an announcement to the electrical trade of its facilities for supplying mica. With a factory having 48,800 square feet of floor space, and in charge of a well-known expert in insulation, the sufficiency of its facilities and the character of its product cannot be questioned.

KENDRICK & DAVIS, Lebanon, N. H., are pushing a new gas engine igniter, pleasing in design and thoroughly well made. The brushes and holder are easily removed, without disturbing the connection. All the parts which are subject to wear have been made interchangeable, and great care has been taken to render all parts likely to give trouble so substantial and adapted to their function that defective working is reduced to a minimum.

FORD AUTOMATIC BOILER CLEANER COMPANY, of St. Louis, report business good. They are working their plant to its full capacity. Last week they received orders for fifteen cleaners from the Morris-Butts Company, owners of the Kansas City Ice & Cold Storage Company; four from the Baltimore Hotel, Kansas City; eight from the East St. Louis Ice & Cold Storage Company; three from the Woodward & Tiernan Printing Company, St. Louis, and several others.

THE GOULD STORAGE BATTERY COMPANY reports good progress in the storage battery arena. Its recent installation for the Canton Electric Il-

luminating Company, of Canton, Pa., is one of its latest successes, while a letter just received from the Lansing Street Railway Company tells how Gould batteries brought sunshine to a dark corner. The Lansing battery plant is said to reduce the generator requirement one half. The Gould automobile battery in Baker vehicles is making a record.

NIAGARA POWER.—The General Electric Press has scored another triumph in a beautiful pamphlet entitled "Niagara Power on the Street Railways of Buffalo and Vicinity." The illuminated cover is an artistic production such as one scarcely expects to find in connection with trade literature, and yet the design makes it entirely appropriate for this use. The pamphlet illustrates and describes various details of Buffalo electric railway plants, the half tone cuts being fine specimens of the engraver's art.

THE WARD LINE STEAMSHIP SANTIAGO was recently equipped with Sturtevant fans for forced draft. As a result, two Scotch boilers under forced draft are now doing the work which originally required four similar boilers under natural draft, and further, a fuel saving of four tons of coal per day has been made. The average revolutions have been increased by three per minute and a considerable portion of the space originally occupied by coal bunkers has now been converted into valuable freight space.

CONVERTIBLE STREET CARS.—The J. G. Brill Company, Philadelphia, Penn., in a 24-page pamphlet describes in detail the Brill convertible street car, a new form of car for use all the year around. The Brill company more than 20 years ago designed, patented and built a convertible car, but owing to limited demand its manufacture was dropped after a few years. About two years ago Mr. John A. Brill took up the problem again, and the present car is the result, which is claimed to be an entirely satisfactory solution. Many cuts show every detail of the car.

GENERAL ELECTRIC BULLETINS.—Among recent General Electric Bulletins is one dated May 7, on small alternating current motors; another dated May 10, on small direct current stationary motors, and four dated May 15, on belt driven railway generators, small plant switchboards, the "tub" arc lamp system, and slow and moderate speed belt driven generators, respectively. The first mentioned bulletin is of special technical interest, as it gives full details of a line of small single-phase self-starting motors, all of the parts being illustrated in details, and illustrations included of the condenser compensator. This latter apparatus consists of a condenser in connection with a transformer for raising the voltage and thereby reducing the condenser capacity. The line of small direct current motors described in the bulletin of May 10 are of the so-called ironclad type, and range from ⅛ to 2-hp, the speeds ranging from 2,300 to 1,800 r. p. m.

CHANGE IN SIXTY-NINE YEARS.—A writer in the New York *Press* says: I have just looked upon two pictures, one entitled "DeWitt Clinton and Train—1831" and the other "Empire State Express—1900." The former shows the primitive locomotive DeWitt Clinton, belonging to the New York Central Railroad, drawing a train of three old Concord stage coaches at its top speed of 15 miles an hour over the 17 miles of track which constituted the New York Central System sixty-nine years ago. It is most comical. The latter exhibits the Empire State Express, going 65 miles an hour with its splendid train of rolling palaces on a part of the same "system," now grown from 17 miles to 10,453. The road's equipment in 1831 was one engine and three made-over stages; to-day it is 3,580 locomotives, 185 sleeping and parlor cars, 3,600 passenger, baggage, mail and express cars, and 150,400 freight cars. This equipment carried over 52,000,000 passengers in 1899, and more than 103,000,000 tons of freight. Something of a contrast.

Record of Electrical Patents

UNITED STATES PATENTS ISSUED JUNE 18, 1901.

[Conducted by William A. Rosenbaum, Patent Attorney, Times Bldg., N. Y.]

676,426. RHEOSTAT CONTROLLER; J. Dillon, Milwaukee, Wis. App. filed Mar. 22, 1901. A combination of levers, latches, dash-pot and spring.

676,436. TELEGRAPHIC INSTRUMENT; H. T. Johnson, Jersey City, N. J. App. filed July 5, 1900. The key helps move the lever of the sounder so as to improve the sluggish action of the latter.

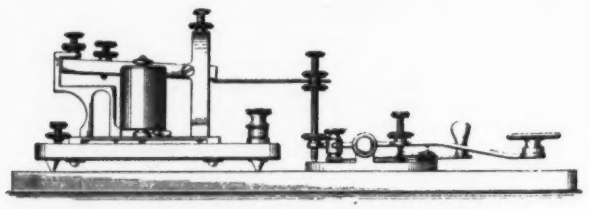
676,439. POLE PIECE FOR DYNAMO ELECTRIC MACHINES; F. A. Merrick, Johnstown, Pa. App. filed Mar. 20, 1901. The pole piece is built up of laminations, the ends or horns being of slightly greater distance from the armature surface than the middle portion.

676,441. FAN SUPPORT; F. P. McBerty, Warren, Ohio. App. filed June 12, 1900. A universal joint is inserted between the motor frame and standard.

676,514. PROCESS OF MAKING CARBIDE OF CALCIUM SIMULTANEOUSLY WITH SILICIDE OF IRON; Walther Rathenan, Berlin, Germany. (See p. 1115.)

676,517. SUPERVISORY SIGNAL FOR TELEPHONE SWITCHBOARDS; C. E. Scribner, Chicago, Ill. App. filed Aug. 15, 1898. The present invention contemplates the use of electromagnetic supervisory signals controlled by the relays, each signal having two windings differently disposed, one of which is in a local circuit closed in making connection with a line, and the other of which is in a branch of the local circuit controlled by the supervisory relay, to be closed when the relay is excited.

676,520. ELECTRIC MOTOR; A. P. Warner, Milwaukee, Wis. App. filed Oct. 22, 1900. An electric motor, comprising an armature, a shunt field-winding around the armature, a starting-resistance in the armature circuit, and an additional field-winding in shunt around a part or all of the starting resistance.



676,436.—Telegraphic Instrument.

676,524. ELECTRODE FOR SECONDARY BATTERY; Wilson H. Abbey and Jacob Altmos, Cleveland, Ohio. App. filed Aug. 25, 1900. (See p. 1108.)

676,575. ELECTRIC FURNACE; Alfred H. Cowles, Cleveland, Ohio. App. filed July 6, 1895; divided and present application filed Apr. 9, 1897. (See page 1115.)

676,576. ELECTRIC SMELTING PROCESS OF REDUCING SODIUM COMPOUNDS; Alfred H. Cowles, Cleveland, Ohio. App. filed June 18, 1901. (See p. 1115.)

676,577. ELECTRIC SMELTING PROCESS OF REDUCING SODIUM COMPOUNDS; Alfred H. Cowles, Cleveland, Ohio. App. filed July 20, 1895; divided and present application filed Sept. 27, 1900. (See page 1115.)

676,583. ELECTRICAL APPARATUS; T. B. Kinraide, Boston, Mass. App. filed Aug. 13, 1900. Means for producing a continuous or unidirectional discharge, consisting of electrodes, one of which has a discharge point and is provided with means for cutting off the receptive area about said point, and another of which has a large receptive area provided with means for preventing the tendency to discharge.

676,604. MASSAGE INSTRUMENT; L. S. Fritze, New York, N. Y. App. filed Mar. 19, 1900. A fat casing containing a battery and having an operating surface, consisting of a number of metal balls, through which the current passes to the body when the instrument is rubbed over the surface of the body.

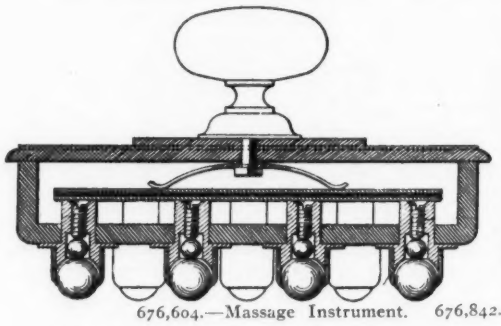
676,618. MAGNETIC SEPARATOR; Thomas A. Edison, Llewellyn Park, N. J. App. filed July 16, 1897. A series of bar magnets are arranged in a stack and ore is fed by gravity on two vertical faces of the magnets. The material rejected from the uppermost magnet passes to the magnet below, and so on to the lower magnet, the final tailings being carried off by a belt. The magnetic ore at each magnet passes into a chute, the several chutes delivering to a conveying belt.

676,738. ELECTRICALLY PROPELLED BOAT; W. R. Edwards, Weybridge, Wyo. App. filed Mar. 2, 1901. A handle by which the direction of rotation of the propeller can be changed and the current to the motor controlled.

676,739. SPEED GOVERNING SYSTEM; S. S. Ekman, Pittsburg, Pa. App. filed Mar. 7, 1901. A speed governor for a prime mover having connections for driving the same separately from the prime mover, the speed of the governor being controlled by the number of alternations of an alternating electric current.

676,744. BURGLAR ALARM; O. J. Gatten, Columbus, Ohio. App. filed Feb. 4, 1901. Details.

676,840-1. MAGNETIC SEPARATING APPARATUS; Thomas A. Edison, Llewellyn Park, N. J. Apps. filed Jan. 9, 1901, and June 18, 1901. A circular magnet forms a pulley over which a conveying belt passes, to which ore is fed. The magnetic particles adhere to the belt and drop off on one side of a partition, the non-magnetic particles dropping off earlier on the other side of the partition. Several of these elements are arranged one above the other, and the rejected material of an upper belt becomes the working material of the belt below.



676,604.—Massage Instrument. 676,842.—Incandescent Lamp.

676,842. INCANDESCENT LAMP; C. Hoelscher, Warren, Ohio. App. filed May 25, 1900. The metallic terminals which engage with the lamp socket are anchored in cement contained in the neck or mount of the lamp.

676,849. CIRCUIT BREAKER TRIP; A. J. Purinton, Waterbury, Conn. App. filed May 9, 1900. Details.

676,853. ELECTRICALLY ILLUMINATED CROSS; H. J. Schlacks, Chicago, Ill. App. filed Apr. 22, 1899. A skeleton frame in the shape of a cross supports tubular lamps, which at night define the shape of the cross.

676,854. AUTOMATIC TELEGRAPH; H. Shoemaker, Philadelphia, Pa. App. filed Feb. 12, 1901. Quick action of the magnets is obtained by means of a short reversing circuit, which helps to kill the magnets immediately after they have attracted an armature.

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ELECTRICAL WORLD AND ENGINEER

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Vol. 37. No. 26

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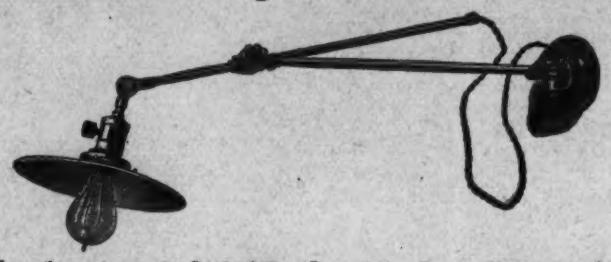

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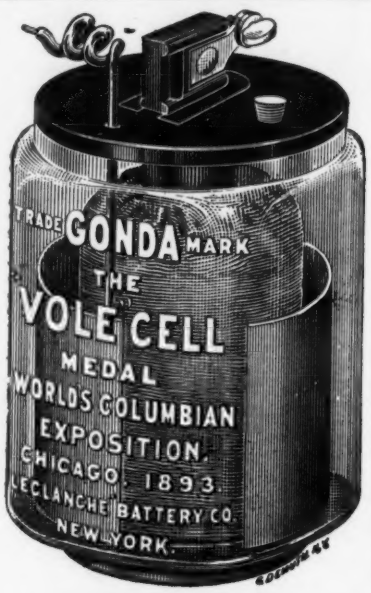

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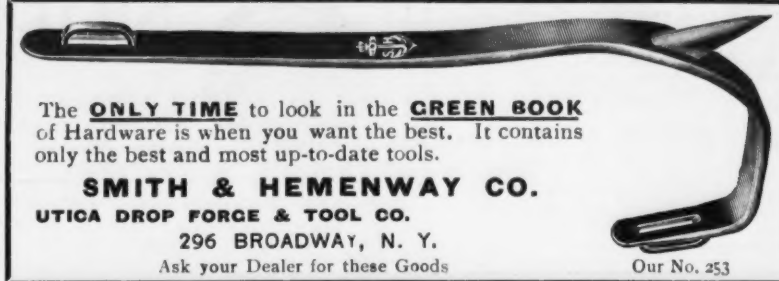

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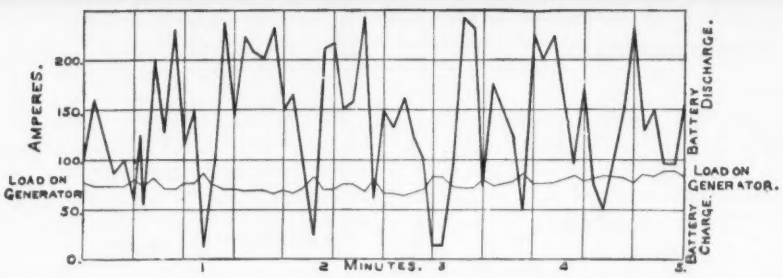

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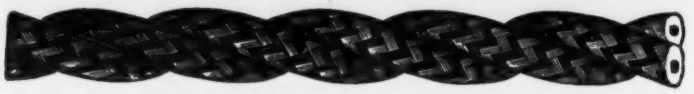

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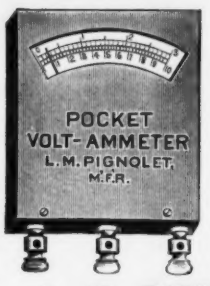

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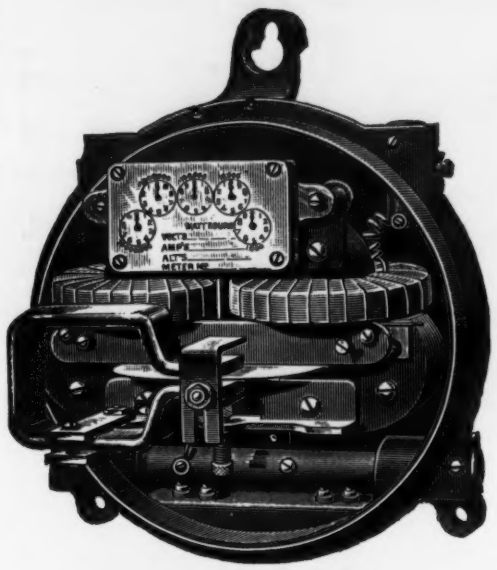

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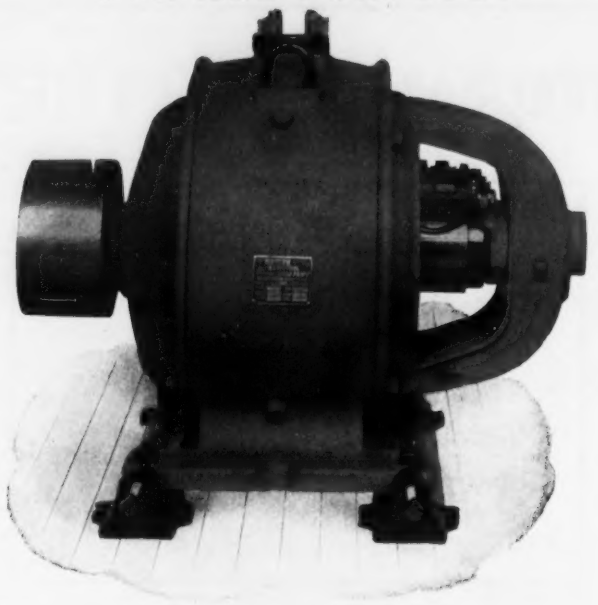

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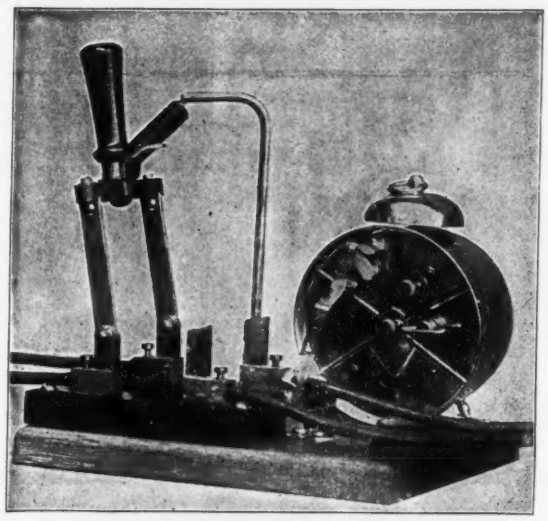

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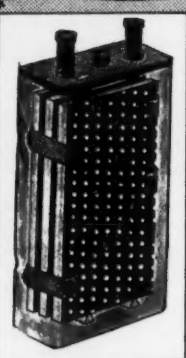

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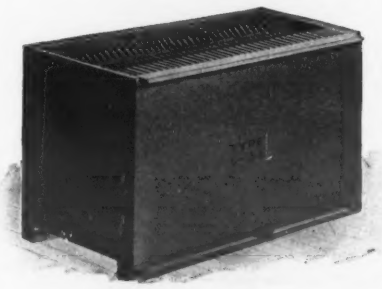

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SACHS NOARK FUSES ON A SWITCHBOARD ARE BETTER THAN AN INSURANCE POLICY. THEY ARE A PREVENTATIVE

Fuses and Blocks

220 Volts 1 to 400 Amp.
500 Volts 1 to 600 Amp.
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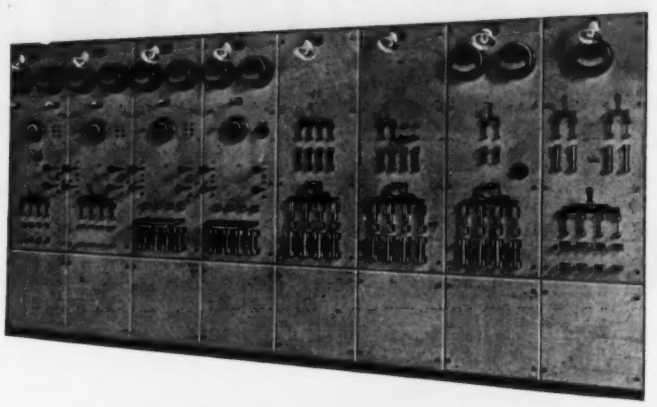

Two Phase 440 Volt Switchboard fitted with Snap and Switch Contact Noark Fuses

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"Noark" Edison Fuse Plugs
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High Service Fuse Boxes
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Can be used at or below rated voltage

Are the highest grade of safety cutout appliances

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For Fan Motors, Jewelers' and Dental Lathes, Miniature Lamps, Gas Engines for Automobiles and other purposes, Laboratory Work, etc. An ideal Battery for Telephone work, special size. No local action. Does not polarize. Cleanliness, Ease of Operation, High Efficiency, Economy, Simplicity of Construction ∴ ∴ TWO STANDARD SIZES

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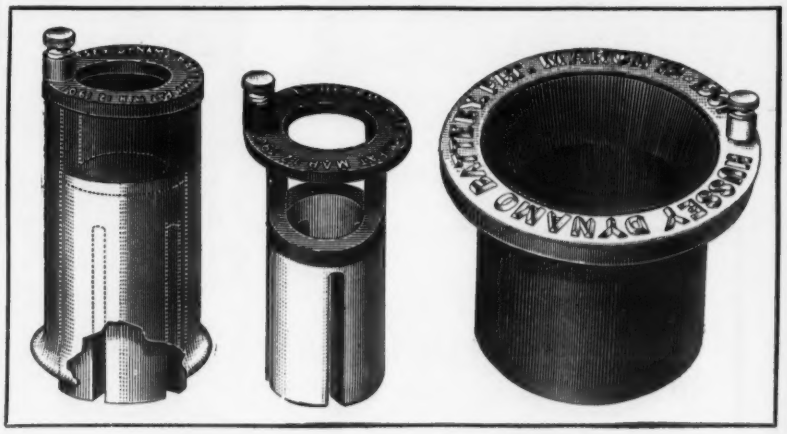
PRICE PER CELL WITH ONE POUND BISULPHATE OF MERCURY, $4.00



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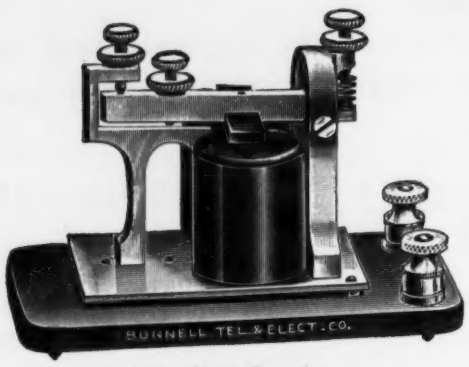

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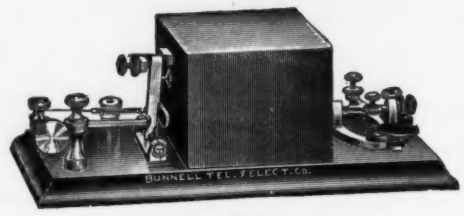

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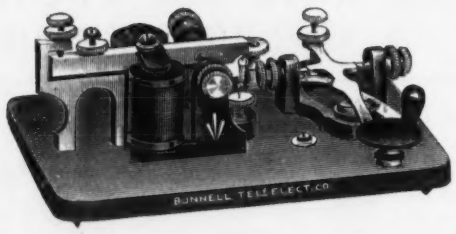

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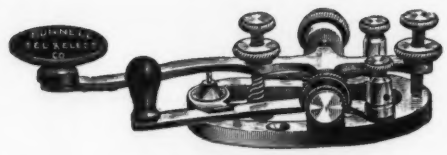

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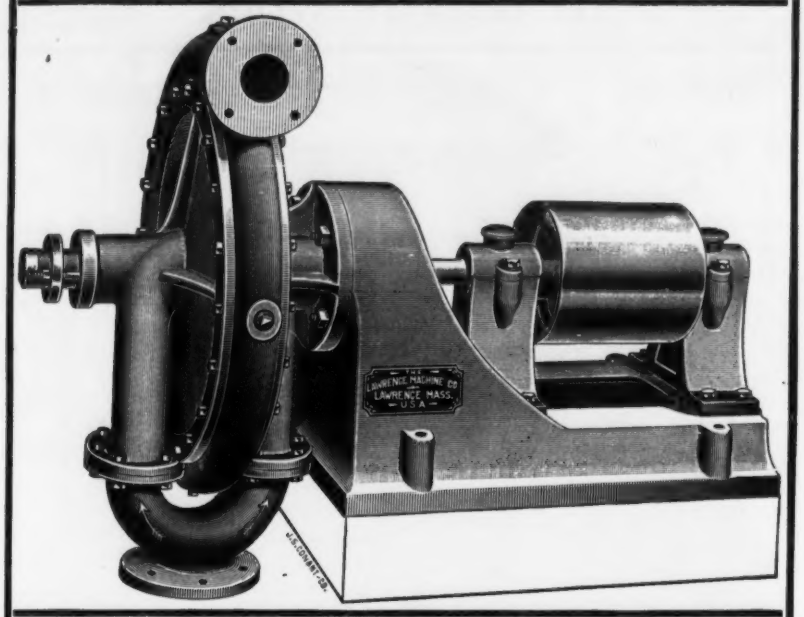

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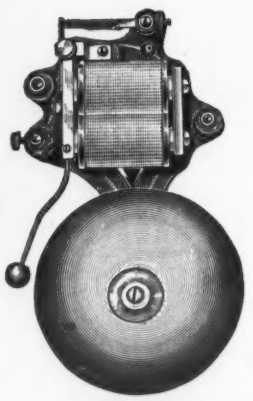

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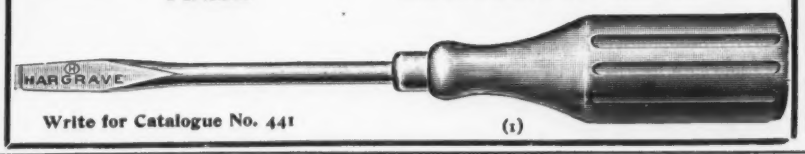

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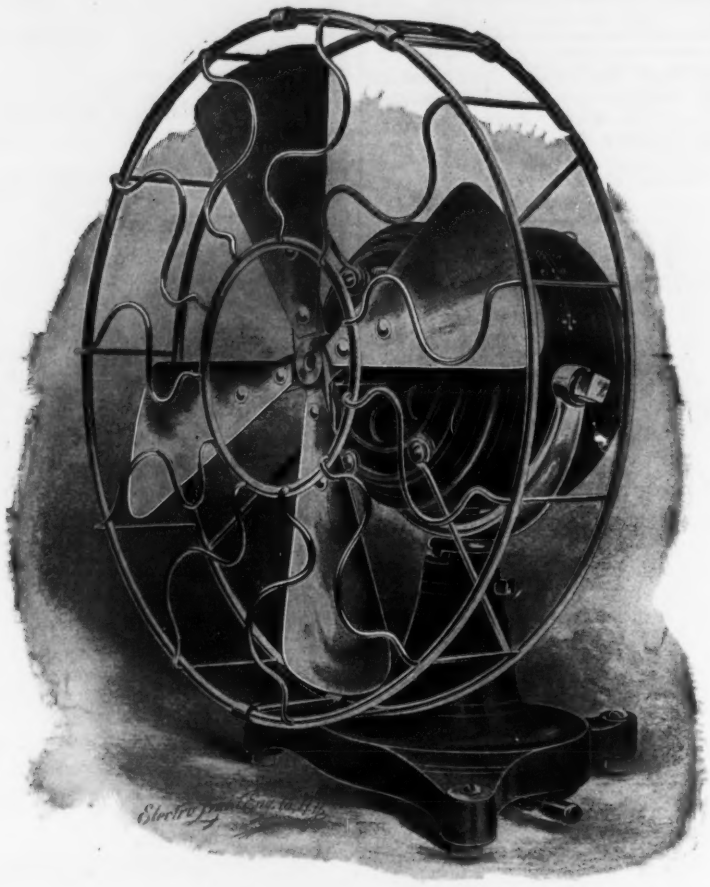

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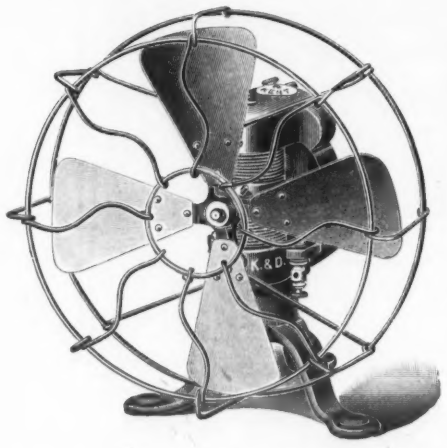

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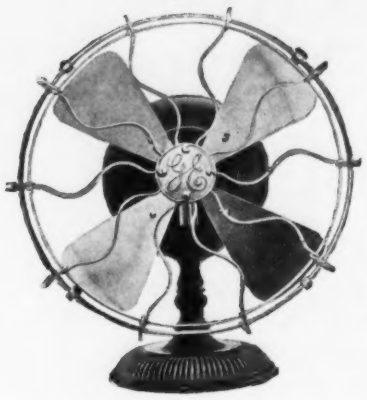

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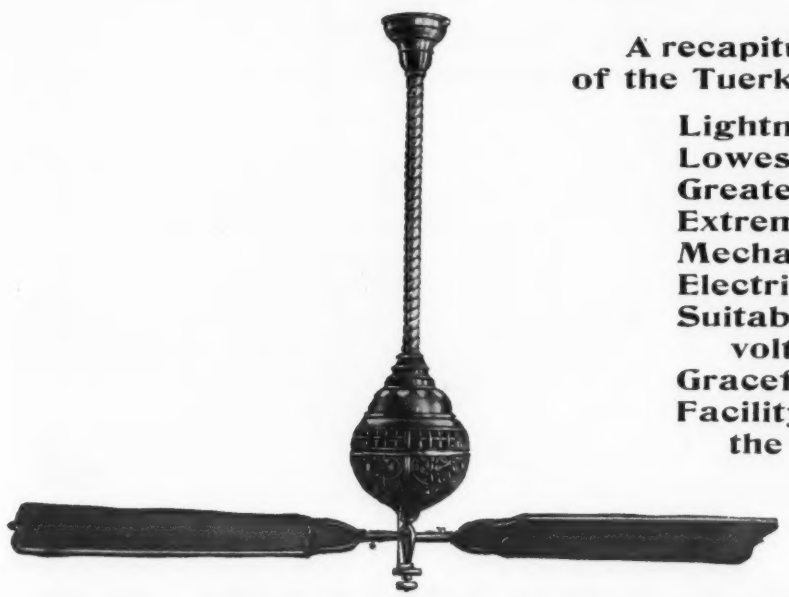

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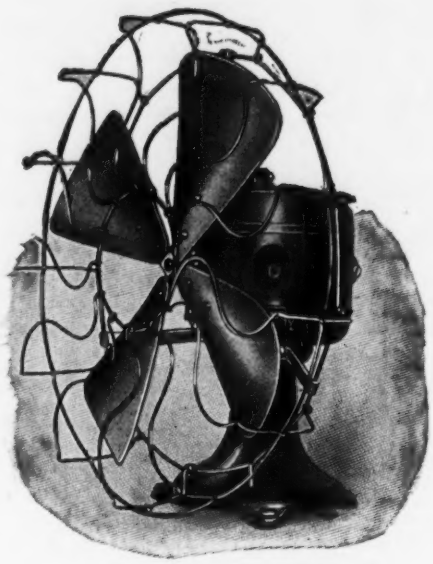

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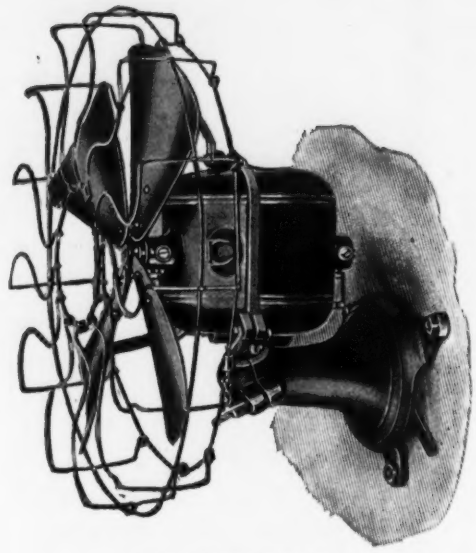

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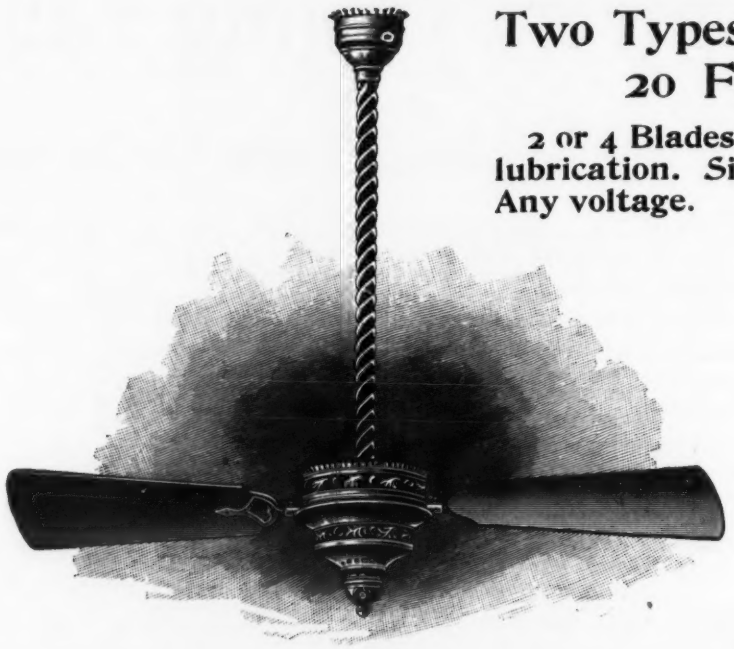

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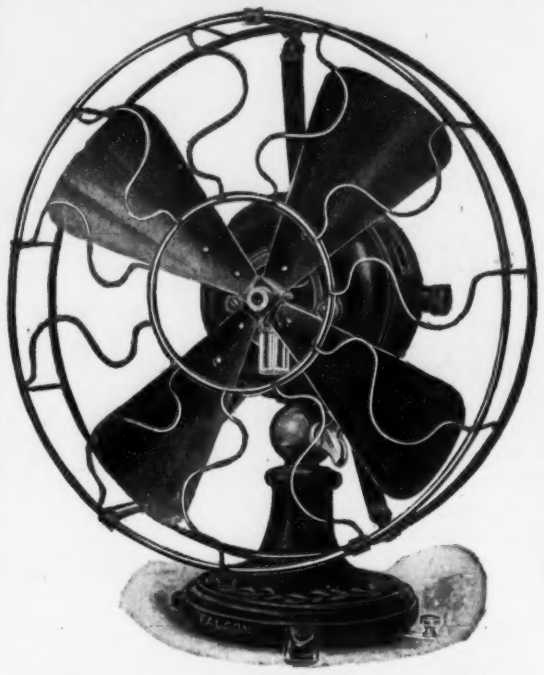

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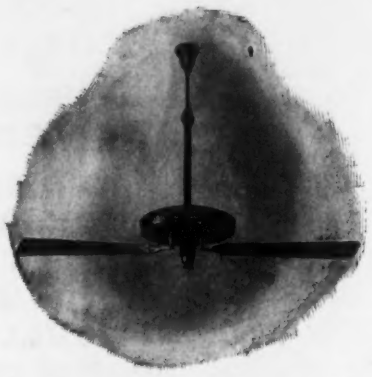
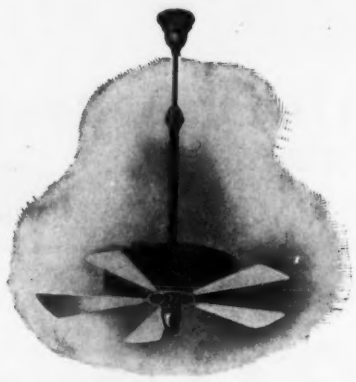
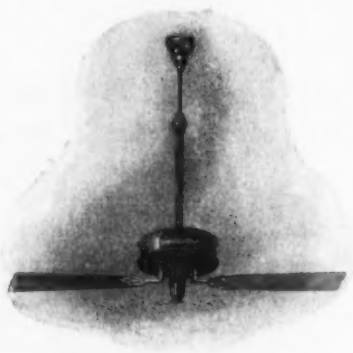


Standard model low frequency Ceiling Fan, 2 blades, 56-inch sweep.



Standard model high frequency Ceiling Fan, 5 blades, 30-inch sweep



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THE ONLY PERFECT ALTERNATING CURRENT FAN

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Standard model swivel base 3 speed Desk Fan

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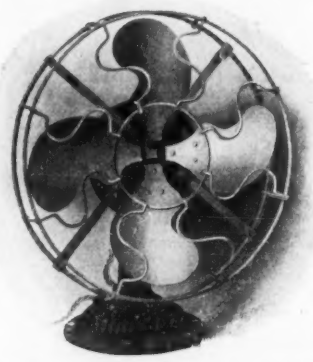

Special model solid base 2 speed Desk Fan

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SINGER BLDG.

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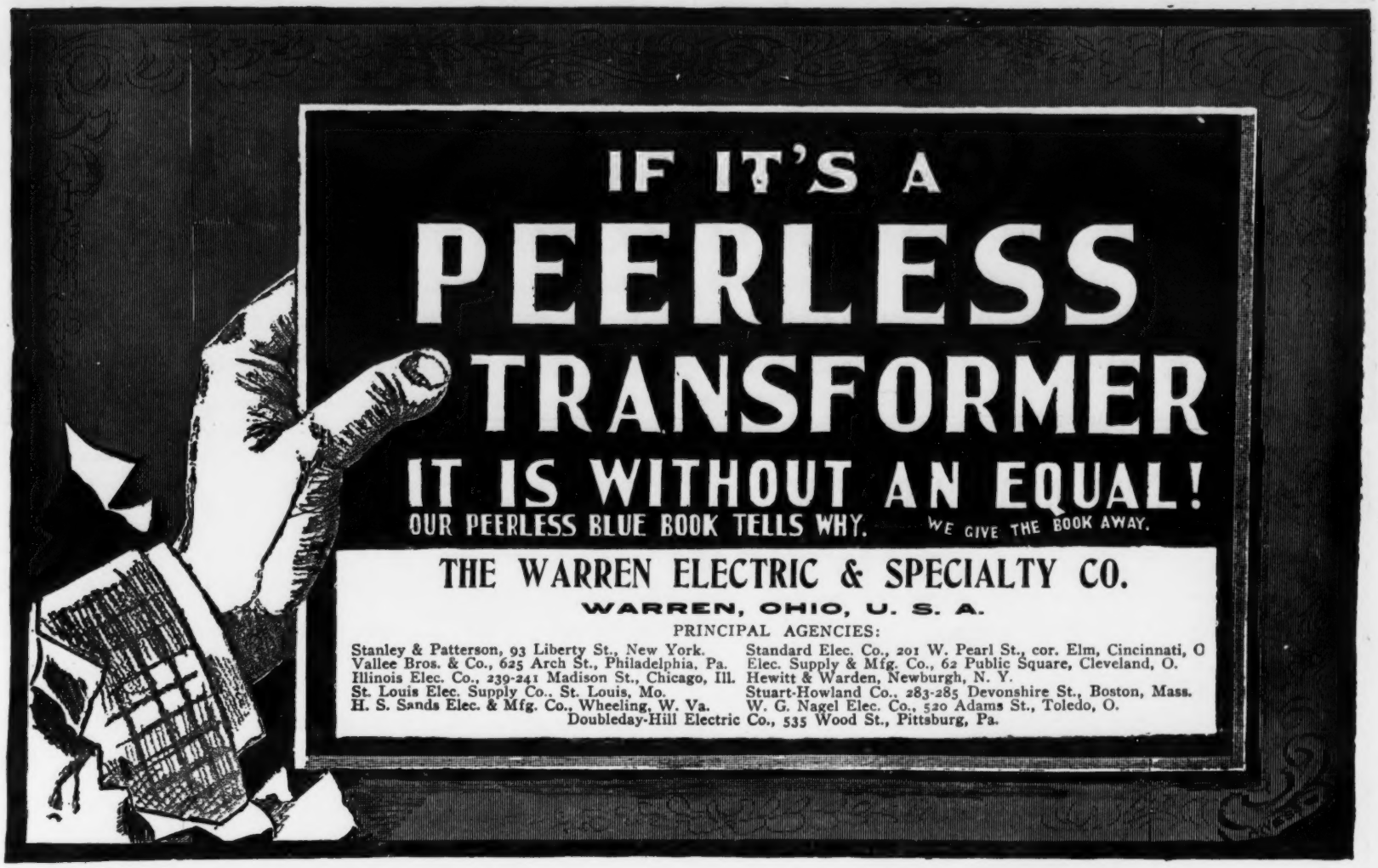
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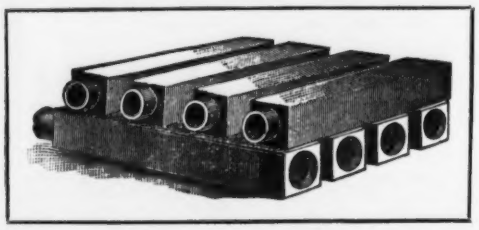

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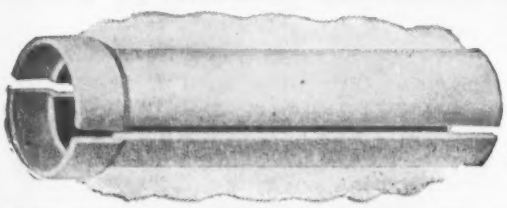

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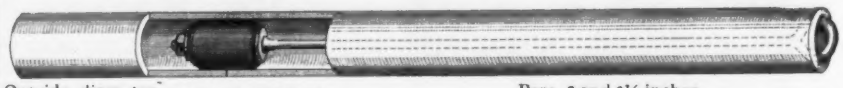

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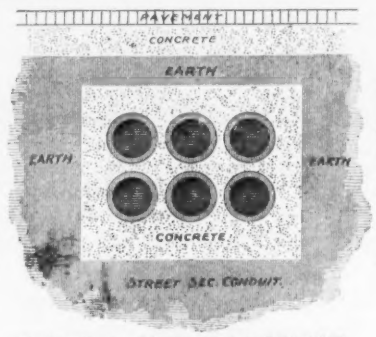

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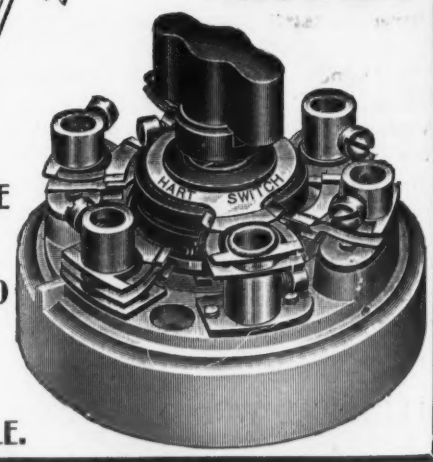

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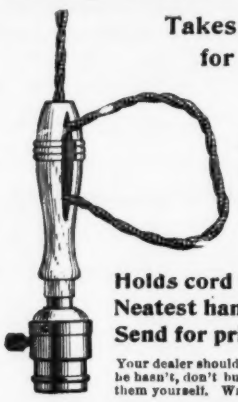

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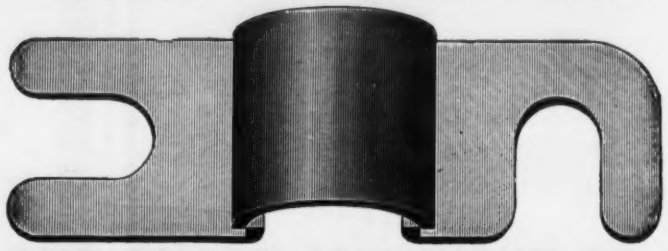

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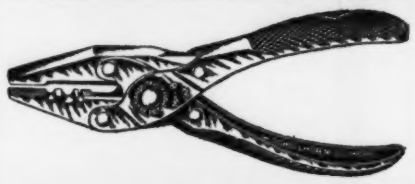

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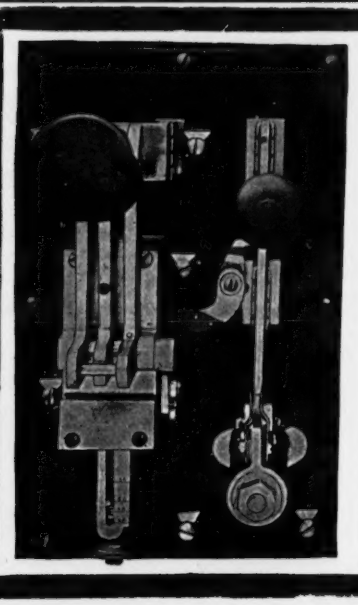

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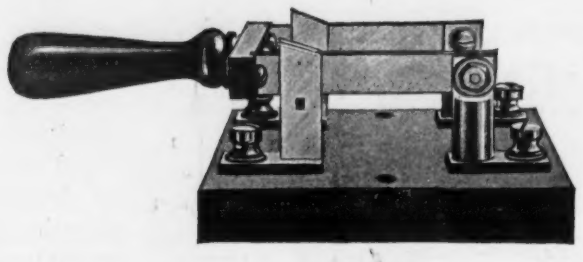

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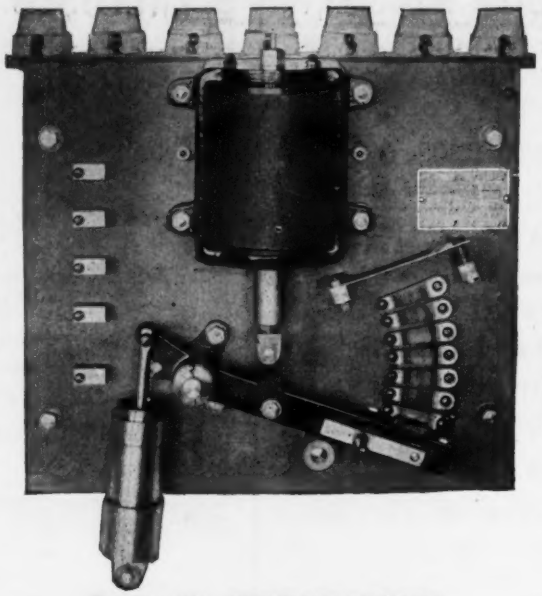

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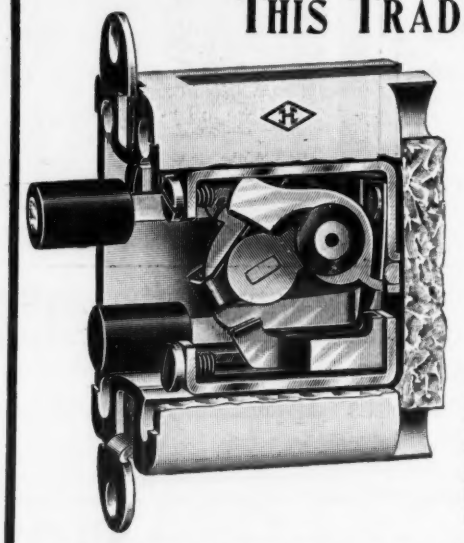

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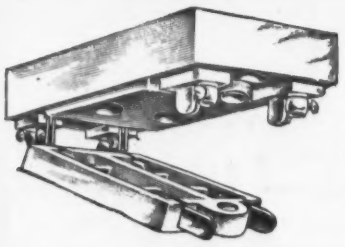

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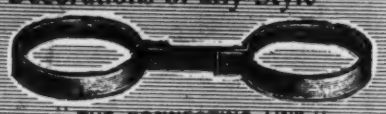

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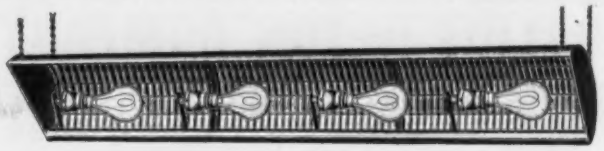

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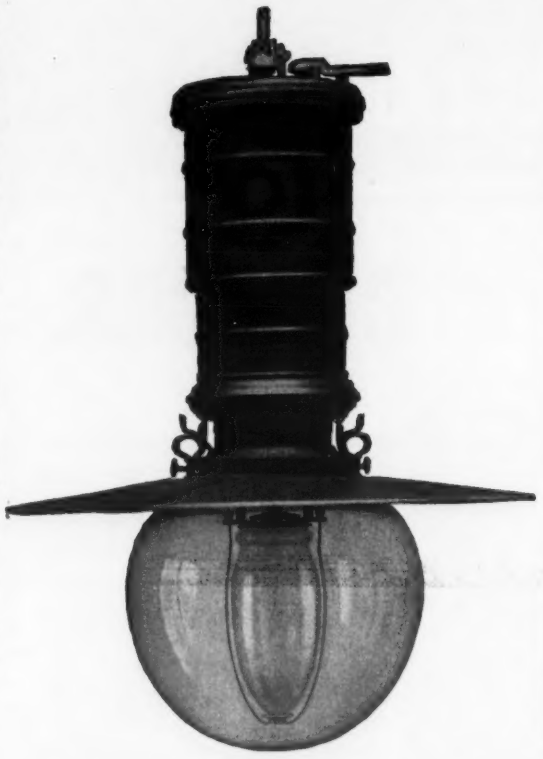

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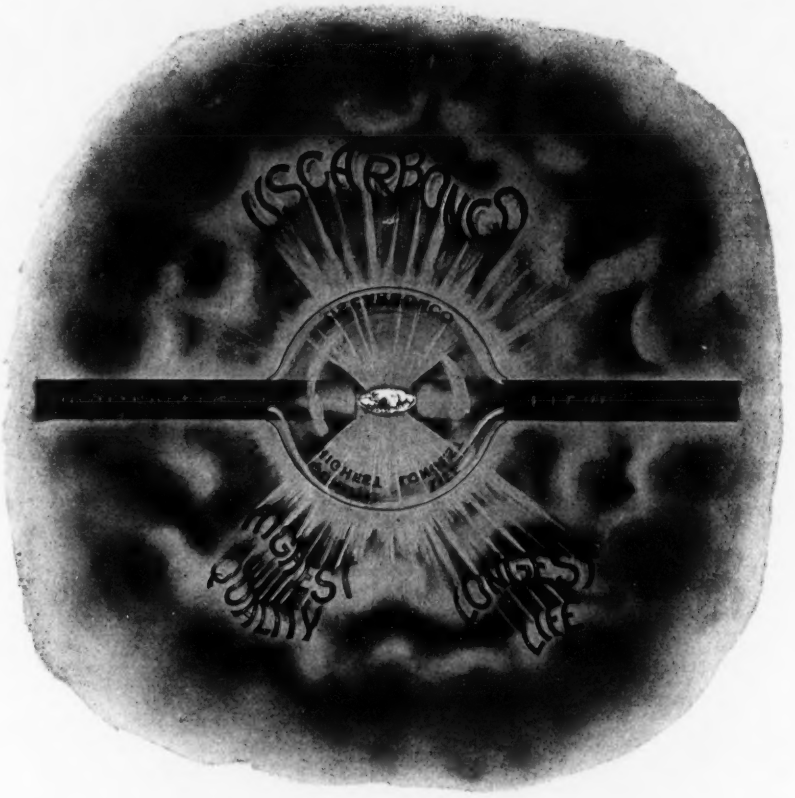

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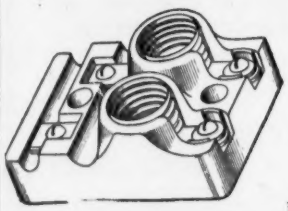

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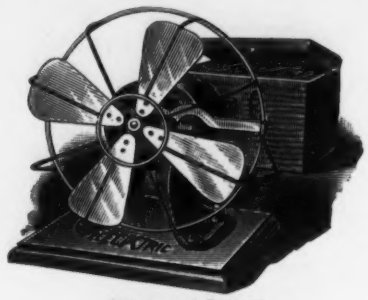

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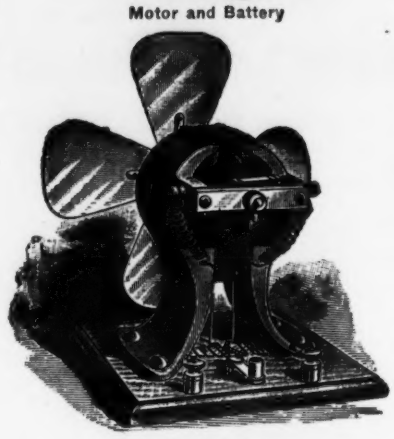

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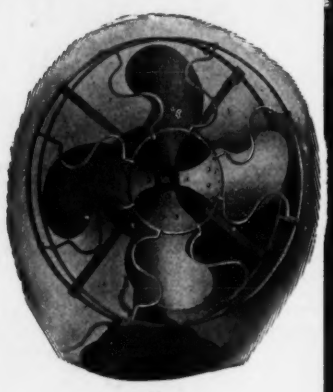

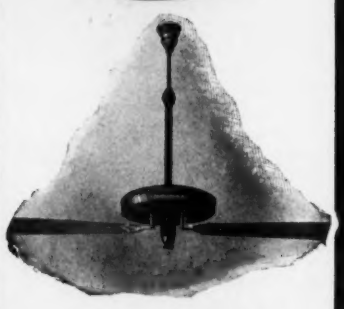

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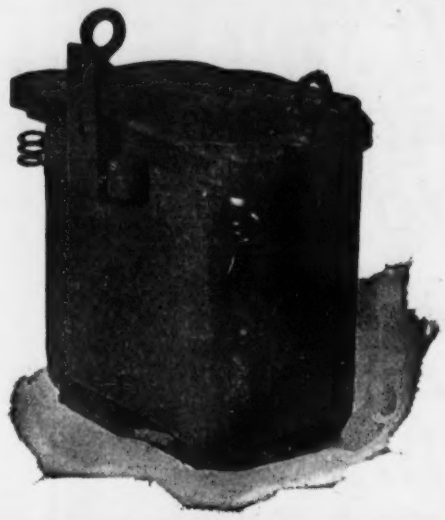

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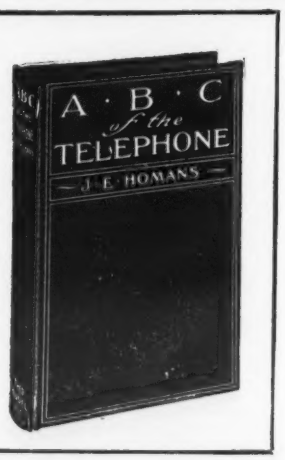

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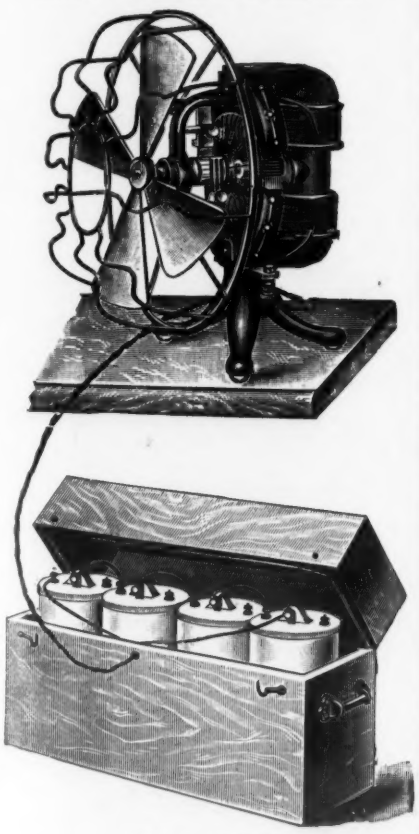

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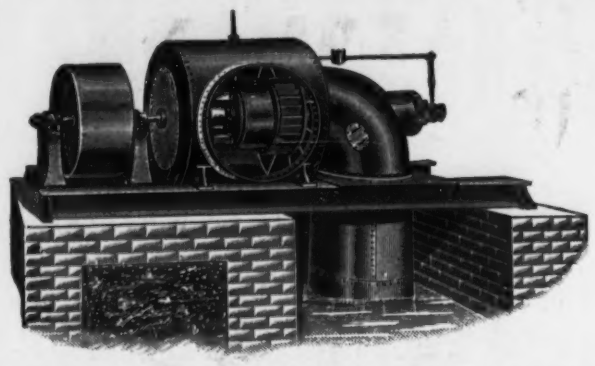

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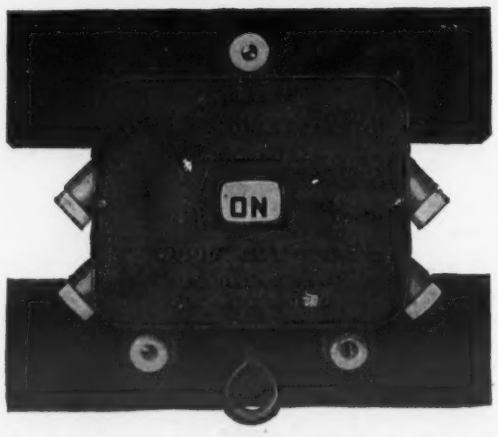

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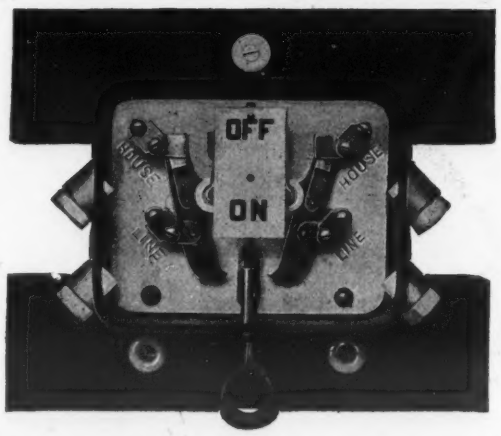

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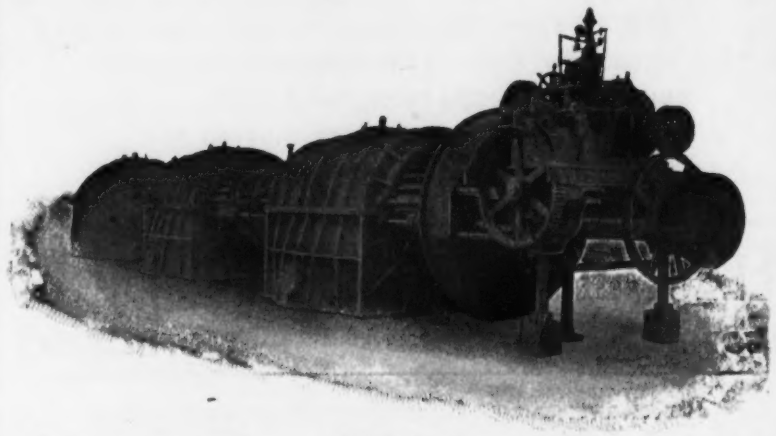

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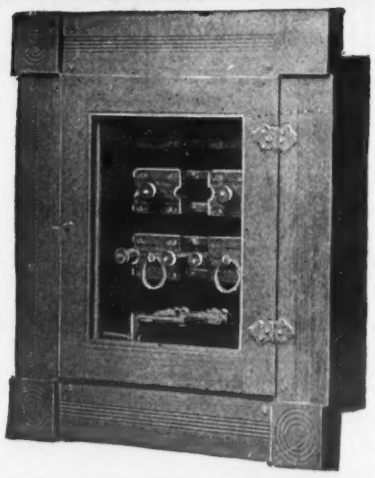

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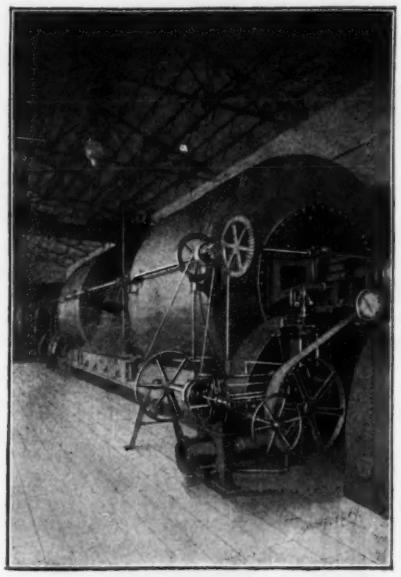

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WANTED IMMEDIATELY.—An experienced incandescent lamp and transformer sales agent; must have best of reference; only first class men need apply; good salary to right person. Address, with full particulars, giving age, experience and references, P. J. P., care Electrical World and Engineer, New York.

WANTED.—Experienced electro-mechanic by large electrical company for wiring and constructing light and power switchboards. Address W. E. M., care Electrical World and Engineer, New York.

WANTED.—A superintendent, with technical and business qualifications, for a small A. C. electric lighting plant; prefer a graduate electrical engineer with some experience in operating plants as superintendent or assistant; state present employment, past experience, salary wanted, personal habits, references, and when services available. Address J. L. LUDLOW, Winston, N. C.

WANTED.—By company manufacturing electric generators, locomotives and coal mining machinery, chief engineer, thoroughly grounded through education and experience in electrical and mechanical work; salary in proportion to experience and attainments, power of initiative, skill in designing and meeting new problems. Give full history and salary expected. GOODMAN MANUFACTURING CO., Halsted St. and 48th Place, Chicago.

WANTED.—Competent electrician to take charge of and maintain shop equipment, including electric cranes, motors and lighting apparatus; shop located within 100 miles of Philadelphia; permanent employment to good man; state wages required and give references. Address Y. M. C., care Electrical World and Engineer, New York.

WANTED.—Competent engineer to run lighting plant, consisting of high-speed engine and General Electric slow-speed alternator; must do firing and sleep in building after closing down 1 o'clock; healthful climate and living very cheap; wages $15 per month; applicant must be of temperate habits, respectful and obliging; give age, nationality, experience and full references to DUNDEE ELECTRIC LIGHT PLANT, Dundee, New York.

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1	200-light		Ft. Wayne, 110 volts, self-exciting, self-oiler.
1	350	"	Thomson-Houston, A 18, self-oiler.
2	600	"	Westinghouse, 30 K.W., toothed armature, 1100 volts.
3	600	"	General Electric, A 30, toothed armature, compound wound, 1100 volts.
1	650	"	Thomson-Houston, A. 35, self-oiler, 1100 volts, composite wound, with exciter.
1	750	"	Brush, self-oiler, toothed armature.
1	750	"	Wood, 37½ K.W., 11,000 volts.
1	900	"	Westinghouse, 45 K.W., self-oiler, composite wound, toothed armature.
3	1000	"	Wood, 50 K.W., self-oiler, toothed armature, latest type, composite wound, complete with exciter.
1	1200	"	Westinghouse, 60 K.W., composite wound, toothed armature.
1	1200	"	Siemens & Halske, 60 K.W., self-oiler, 60 cycle, single phase, revolving field type.
4	1200	"	General Electric A 60, composite wound, toothed armature.
1	1200	"	Westinghouse, 60 K.W., 60 cycle.
1	1200	"	Siemens & Halske, 60 K.W., brand new, 60 cycle, single phase.
3	1300	"	T-H, A 70, 1100 or 2200 volts, complete with exciter.
2	1400	"	Westinghouse, 60 cycle, 70 K. W.
1	1500	"	Warren-Medberry, 75 K.W., 60 cycle, self-oiler, two phase inductor type, new.
1	1500	"	General Electric, monocyclic, 75 K.W., self-oiler, 60 cycle.
1	1500	"	Wood, 75 K.W., complete with exciter.
1	1800	"	Standard, 90 K.W., inductor type.
1	2400	"	Westinghouse, 120 K.W.
2	2400	"	General Electric, 120 K.W.
2	2400	"	Westinghouse, 120 K.W., 60 cycle.
1	4000-light		Wood, 200 K.W.
2	4000	"	Wood-Fort Wayne, 200 K. W., 3 bearings.
1	4800	"	Westinghouse, 240 K.W.

DIRECT CONNECTED GENERATORS.

3	125-light		Fisher, 110-volt, compound, direct connected to vertical engine 6x6, brand new, 7½ K.W., complete outfit.
1	270	"	General Electric, 110-volt, compound, direct connected to Case engine, 15 K.W., complete outfit, new.
1	1350	"	Waddel-Entz, 80 K.W., for direct connection.
1	60 K.W.,		Siemens & Halske, 250-volt, brand new, for direct connection.
1	120 K.W.,		Siemens & Halske, 250-volt, brand new, for direct connection.

220-250-VOLT GENERATORS.

1	9 K.W.,		Gibbs, M. P., self-oiler.
1	10	"	Lundell multipo,lar.
1	12	"	Card, self-oiler.
1	20	"	Sprague, self-oiler.
1	20	"	T.-H., D 20.
1	20	"	Siemens & Halske, self-oiler.
1	25 K.W.,		C. & C., self-oiler.
1	30	"	Westinghouse, M.P.
2	40	"	General Electric, M.P., new.
2	50	"	General Electric, M. P., new.
1	60	"	Siemens & Halske, M.P. type, brand new, for direct connection.
1	120	"	Siemens & Halske, M.P., self-oiler, brand new, direct connection.

500-550-VOLT GENERATORS.

1	15 K.W.,		Edison, self-oiler.
1	25	"	Commercial, self-oiler.
1	33	"	Wood, M.P., self-oiler.
2	40	"	Siemens & Halske, M.P.
2	40	"	General Electric, M.P., self-oilers, compound, new.
5	45	"	Edison, compound, self-oilers.
1	60	"	Edison, self-oiler, compound.
1	80	"	General Electric, M.P., 80, comp., self-oiler.
2	90	"	General Electric, M.P., 90, self-oilers, comp.
1	100	"	General Electric, M.P., 100, self-oiler, comp., slotted armature, August delivery.
2	150	"	Detroit (Rae) M.P., comp.
1	150	"	Westinghouse, M.P., compound, self-oiler.
1	500	"	Westinghouse, M.P., 375, K. W., August delivery.

110-125-VOLT GENERATORS.

1	1	H. P.	Westinghouse, M. P., self-oiler.
1	2	"	Eddy, self-oiler.
1	2	"	Mayo, slow speed, self-oiler.
1	3	"	Jenney, self-oiler.
1	3	"	Standard, self-oiler.
1	3	"	Card, Cincinnati, M. P.
1	4	"	Mather, self-oiler.
1	4	"	Edison, self-oiler.
3	5	"	Westinghouse, self-oilers.
1	5	"	Commercial, self-oiler.
1	5	"	Westinghouse, M.P., self-oiler.
2	5	"	Siemens & Halske, M. P.
1	6½	"	C & C, M.P.
1	7½	"	Eddy, type C, self-oiler.
1	7½	"	Card, self-oiler.
2	7½	"	Westinghouse, M. P., self-oilers.
1	7½	"	Gibbs, M. P.
1	9	"	Gibbs, M.P.
1	10	"	Edison, 8½ K.W., self-oiler.
1	10	"	Card (Cincinnati), self-oiler.
2	10	"	Gibbs, M.P.
1	12	"	Eddy, self-oiler.
1	15	"	Rockford, self-oiler.
3	15	"	Edison, 12 K.W., self-oilers.
1	15	"	Siemens & Halske, M. P.
1	18	"	T.-H., D. 15.
1	18	"	Commercial, self-oiler.
1	18	"	Eddy, self-oiler.
2	18	"	Card, self-oilers.
3	18	"	Edison, 15 K.W., self oilers.
1	20	"	Eickmeyer.
1	20	"	Columbian, M. P.
3	20	"	Westinghouse, M. P., slow speed, self-oilers.
1	24	"	Eddy, self-oiler.
1	25	"	Western Electric, self-oiler.
1	25	"	Edison, 20 K.W., self-oiler.
1	25	"	Duplex, M. P., self-oiler, slow speed.
1	25	"	National, self-oiler.
1	25	"	Siemens & Halske, self-oiler.
1	25	"	Fisher, M. P., self-oiler.
4	35	"	Edison, 30 K.W., self-oilers.
2	35	"	Siemens & Halske, self-oilers.
2	50	"	General Electric, M.P., 40 K. W., slow speed, new.
1	50	"	Westinghouse, 10 pole, slow speed, 40 K.W., self-oiler.
2	60	"	General Electric, M. P., self-oilers, 50 K.W., new.
1	75	"	Siemens & Halske, 60 K.W.

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1—200 K.W. Westinghouse.
2—100 K.W. General Electric.
3—150 " Edison bi-polar.
2—100 " Edison bi-polar.
2— 90 " M.P., T.-H.
2— 80 " M.P., T.-H.
1— 75 " Walker.
2— 75 " M.P., T.-H.
1— 60 " Edison bi-polar.

500-VOLT MOTORS.

1— ¼ H. P. Crocker-Wheeler.
1— 1 " Crocker-Wheeler.
1— 3 " C & C.
1—10 " Edison.
1—15 " Edison.
1—20 " Eddy.
1—25 " M. P. Excelsior.
1—25 " C & C.
1—75 " Edison.

220-VOLT APPARATUS.

4—200 K. W. Walker M.P.
1—200 " Jenny, M.P.
10—25 H. P. G.E. 52 Ry. type stationary motors.
4— 10 " Lundell slow-speed motors.
1— 45 K. W. 250-volt Edison.
1— 7½ H. P. Edison.
1— 4 " Edison.
1— 5 " Edison.
1— 5 " M.P. Excelsior.
1— 10 " M.P. Excelsior.
1— 10 " bi-polar Excelsior.
1— 10 " Enclosed type G.E.

1—25 K. W. Eddy dynamo direct connected to 10x12 Russell engine.
1—25 " Eddy dynamo direct connected to Skinner engine.
1—25 H. P. M.P. Excelsior.
2— 7½ " Crocker-Wheeler.
1— 1 " Eddy.

ALTERNATORS.

3—A120 K. W. T.-H. 1140-volt.
2—A120 " T.-H. 2240-volt.
1—A100 " T.-H. 1140-volt.
2— 60 " Westinghouse, 2-phase, 60-cycle, 2200-volts.
2—A 60 " T.-H. 1140-volt.
1—A 70 " 1140-volt.
1— 30 " National, 1140-volt.
2— 30 " Westinghouse 1140-volt.

ALTERNATING CURRENT MOTORS.

1— 2½ H. P. 100-volt, single-phase, 125-cycle.
2— 5 " Ft. Wayne, 125-cycle, single-phase.
1— 10 " Excelsior, 60-cycle, single-phase.
1— 4 " Wagner, 125-cycle, single-phase.
1— 1 " Emerson, 60-cycle, single-phase.
1—250 " Westinghouse, 60-cycle, 2-phase.

2—100 H. P. G.E., 60-cycle, 3-phase
1— 1 " G.E., 125-cycle, single-phase.
1— 7½ " G.E., 125-cycle, single-phase.

110-VOLT DYNAMOS.—COMPLETE.

1— 25 K. W. Eddy, direct connected to Russell Engine.
2— 45 " Manchester, Westinghouse type, direct connected to Armington & Simm's vertical engine.
3— 60 " Siemans Halski, direct-connected type.
1—D50 " T.-H.
2— 60 " Edison bi-polar.
2— 45 " " "
2— 30 " " "
2— 25 " " "
2— 20 " " "
2— 15 " " "
1—100 " " "
1—120 " Weston-Electric.

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7—Equipment of Westinghouse No. 12 A motors.
7—Westinghouse No. 38 motor shells.
35—Westinghouse No. 3 armature cores.
30—Westinghouse No. 3 motor frames, shells and field plates.
40—Complete two-motor equipments, West. No. 3 motors and G controllers.
25 H.P. Westinghouse No. 3 armatures complete.
19—Brill's 21 A trucks, standard gauge.
14—McGuire Columbia trucks, standard gauge.
18—Peckhams 6 C.X. standard gauge.
30—8-bench open cars, length over numbers 26 ft. 4 in., width over sills 6 ft. 3 in., equipped with two West. No. 3 motors, G controllers, Brill's 21 A trucks standard gauge.
10—Complete motor equipments, G. E. 1200's with K. 2 controllers.
2—Double-truck vestibule cars transverse rattan seats.
9—16-feet Stephenson box cars with Peckham's trucks, West. No. 3 motors.

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A full line of standard and narrow gauge freight, passenger, saddle tank, and contractors' locomotives.

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A full line of type F. oil, G. and H. Stanley and Westinghouse, single and double primaries.

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A full line of series, enclosed and incandescent arc lamps.

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EQUIPMENTS

110-125-VOLT INCANDESCENT DYNAMOS.

1 16-light Westinghouse M.P., self-oiler.
1 30 " Eddy, compound, self-oiler.
1 50 " Mather.
1 50 " Card (Cincinnati) M.P., self-oiler.
1 55 " Edison, 3 K.W.
3 60 " Westinghouse, compound.
1 65 " Westinghouse, M.P., comp.
1 75 " Kling, self-oiler, compound.
1 80 " Commercial, self-oiler.
1 80 " Siemens & Halske, M.P.
1 90 " C. & C., M.P.
1 100 " Eddy, type C, self-oiler.
1 100 " Jenny, self-oiler.
2 100 " Westinghoue, M.P., comp.
1 110 " Gibbs, M.P., slow speed.
2 125 " Fisher, multipolar, compound, direct connected to 6x6 vertiacl engine.
1 135 " Gibbs, M. P., slow speed.
1 150 " Edison, self-oiler.
2 150 " Gibbs, M.P., compound.
1 190 " Eddy, compound, self-oiler.
1 200 " Rockford, self-oiler.
2 210 " Siemens & Halske, 12 K.W.
3 210 " Edison, 12 K.W., self-oilers.
1 250 " Commercial, comp., self-oiler.
1 250 " Eddy, self-oiler, compound.
1 270 " Thomson-Houston, D. 15.
3 270 " Edison, 15 K.W., compound.
3 270 " Westinghouse, M.P., 15 K. W., slow speed.
1 270 " General Electric, 15 K.W., M.P., direct connected to Case engine, compound, new.
1 275 " King, self-oiler, compound.
2 300 " Card, compound, self-oilers.
1 340 " Eddy, self-oiler, compound.
1 350 " Western Electric, self-oiler.
1 350 " Mather, comp., self-oiler.
4 350 " Siemens & Halske, self-oilers.
1 350 " Edison, 20 K.W., self-oiler.
1 350 " Fisher, M.P., slow speed, new, self-oiler compound.
1 360 " Duplex, multipolar.
5 500 " Siemens & Halske, self-oilers.
3 540 " Edison, 30 K.W., self-oilers.
2 700 " General Electric, M.P., 40 K.W., slow speed, new.
1 700 " Westinghouse, slow speed.
2 900 " General Electric, M.P., 50 K. W., slow speed, new.
1 1000 " Siemens & Halske, type L. H., 60 K.W., self-oiler.

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54-62 S. CLINTON ST. CHICAGO.

ALL MACHINES IN STOCK AT OUR WAREHOUSE.

Large stock of Meters, Arc Lamps, Station Instruments and Supplies. All apparatus fully guaranteed in perfect operative condition. Send for Monthly Bargain Sheet with complete list and net prices.

2 1000-light Edison, 60 K W., self-oilers comp. wound.
1 1350 " Waddel-Entz, 80 K.W., for direct connection, 8 pole.
1 1350 " Siemens & Halske, type L. H., 80 K.W., self-oiler.
1 1500 " Siemens & Halske, type L. H., self-oiler, 100 K.W., compound.

ROTARY TRANSFORMERS.

1 Westinghouse, M.P., self oiler, 500 to 110 volts, 5 H.P. each end.
1 Siemens & Halske, equalizer, M. P., for 3 wire system on 220 volts, 15 K.W., 125 volts each end, new.
1 Siemens & Halske, 100 K.W., each end direct current motor generator, 125 to 500 volts, nearly new, fine, direct coupled on same base.
1 Siemens & Halske, brand new, Churchward type, M.P., rotary transformer, 60 cycle, two phase, 175 volts alt. to 250 volts direct, with marble panel switchboard, all complete, 60 K.W.

ARC DYNAMOS.

1 20-light 2000 C. P. Western Electric.
1 30 " 1200 " T.-H., K. 12.
1 30 " 2000 " T.-H., M. 2.
1 35 " 2000 " T.-H., L. D. 2.
1 35 " 1200 " Wood, No. 6.
1 40 " 2000 " Western Electric, s.o.
1 45 " 1200 " T.-H., M 12, ball arm.
2 45 " 1200 " T.-H., M. 12 new ring armatures.
2 45 " 1200 " Brush No. 7 with latest improved Steubenrausch commutator.
1 50-light, 1200 C.P. T.-H., L. D. 12, ball armature.
1 50 " 1200 " Standard, self-oiler.
1 50 " 2000 " Standard.
1 50 " 2000 " T.-H., M. D. 2.
2 50 " 2000 " T.-H., M. D. 2, new ring armatures.
4 50 " 2000 " T.-H., M. D. 2, ring armatures.
1 60 " 2000 " West. Elec., self-oiler.
1 60 " 2000 " Westinghouse.
4 60 " 2000 " Wood, No. 8.
1 65 " 2000 " Brush No. 8, with new armature, with Steubenrausch fireproof commutator.
1 75 " 1200 " Wood, with new armature.
1 75 " 1200 " Standard.
2 75 " 2000 " Westinghouse, self-oilers.
3 125 " 1200 " Excelsior, latest type.

220-250-VOLT MOTORS.

1 ¼ H. P. Lundell.
1 2 " Thomson-Houston.
1 2½ " Wood, Ft. Wayne, self-oiler.
1 2½ " Gibbs, M.P., self-oiler.
1 3 " Mather, self-oiler.
1 3 " Kester, self-oiler.
1 3 " T.H.
1 3 " Card, slow speed, self-oiler.
1 5 " Akron, self-oiler.
19 5 " Gibbs, M.P., self-oilers.
1 6 " Mather, square top, self-oiler.
1 10 " Eickmeyer, elevator motor.
1 10 " Gibbs, M.P., slow speed.
1 13 " Lundell, M.P., self-oiler, slow speed.
1 15 " Card, self-oiler.
1 15 H.P. Eddy, self-oiler.
1 15 " Mather, ring type, new armature.
1 25 " Sprague, self-oiler.
1 25 " Thomson-Houston, D. 20.
1 25 " Siemens & Halske, self-oiler.
1 30 " C. & C., self-oiler.
1 50 " Northern, M.P., self-oiler, new.
2 50 " General Electric, M.P., new, slow speed.
2 60 " General Electric, M. P., newly rewound.

500-550-VOLT MOTORS.

1 5 H. P. Detroit.
1 5 " Westinghouse, self-oiler.
1 5 " Sprague.
1 5 " Eddy.
1 5 " Westinghouse, M. P.
1 7½ " Ford Washburn.
1 7½ " Eddy, self-oiler, new armature.
1 10 " Sulzer-Vogt, self-oiler.
1 18 " C. & C., self-oiler.
1 18 " Edison, self-oiler.
1 30 " Commercial, self-oiler.
1 40 " Wood, 6 pole.
2 50 " Siemens & Halske, M.P.
2 50 " General Electric, M.P., slow speed, new.
4 60 " Edison, 45 K.W., self-oilers.
2 60 " General Electric, M.P., new.
1 75 " Edison, self-oiler, 60 K.W.

ALTERNATING CURRENT MOTORS.

1 1 H. P. Emerson, 16,000 alternations, self-oiler, 104 volts.
2 1 " Westinghouse, 16,000 alternations, 100 volts.
1 2 " Wagner, 60 cycle, 104 volts.
2 5 " Wagner, single phase, 60 cycle, 104 volts.
2 10 " Ft. Wayne, 110 volts, 60 cycle, single phase, self-starting.

AUTOMOBILE MOTORS.

2 4 H. P. Siemens & Halske, 80-100 volts, brand new, M.P.
2 5 " Siemens & Halske, 80-100 volts, M.P., brand new.

AUTOMOBILES.

1 Wood's electric runabout, with top, latest type, new batteries, 1901 model.
1 Electric "trap," carries 4 persons, new.

FOR SALE
Or Exchange

All apparatus shipped by us is in **first-class condition** and will give service **equal to new.**

QUICK DELIVERY LOW PRICES

ALTERNATORS.

1—650 K.W. Stanley (belted).
1—400 " G. E. (new).
2—300 " Stanley, direct connected to McI. & S. engines.
2—300 " Stanley (belted).
1—120 " Westinghouse.
1—120 " General Electric.
1—100 " Wood.
2— 70 " T. H.
2— 60 " General Electric.
2— 60 " Westinghouse.
1— 50 " Wood.
1— 50 " Westinghouse.
1— 45 " "
4— 35 " T. H.
3— 30 " General Electric.
1— 30 " Westinghouse.

ARC DYNAMOS.

2—160-Light No. 12 Brush, multi-circuit.
1—125 " Brush.
2—125 " Wood.
1— 60 " Wood.
3— 50 " Wood.
1— 50 " T. H.
2— 45 " Brush.
2— 35 " T. H.
1— 30 " T. H.

FAN MOTORS.

16,000 alternations, 100 volt.
15—12-inch Fan, G. E., 100 volts.
6—14-inch " G. E., 100 volts.
20—12-inch " West'g, 100 volts.
6—12-inch " Lundell, 100 volts.
8—12-inch " Emmerson, 100 volts.

16,000 alternations, 50-volt.
12—12-inch Fans, G. E., 50 volts.
16—12-inch " West'g, 50 volts.
5—12-inch " Lundell, 50 volts.
10—12-inch " Emmerson, 50 volts.
Fans overhauled in excellent condition.

ARC LAMPS.

300—T. H. M. 12 Double Carbon.
200— " " 2 " "
150— " Improved M Double Carbon.
The above lamps are in fine condition and very cheap.

TRANSFORMERS.
METERS.

Write for our Special Price List.

MAYO & ROHRER CO.
220 Broadway, New York

Bargains in Electrical Machines.

1—600-Lt. Mather dynamo, 115 volts, 900 rev.
3—500 " Edison dynamos, 110 volts.
1—250 " " dynamo, 110 volts.
2—150 " " dynamos, 110 volts.
1—200 K.W. generator, 250 volts.
1— 80 K.W. C & C dynamo, 220 volts.
1— 50 " T. & H. dynamo, 220 volts.
1— 35 " C & C dynamo, 220 volts.
1— 15 H.P. T. & H. motor, 220 volts.
2— 40-arc light Wood dynamos, with lamps.

Large stock of Corliss, high-speed and Automatic Engines, Boilers, Pumps, Heaters and General Machinery.

Local and L. D. 'Phone 261 and 262

FRANK TOOMEY, 127-131 N. Third St., Phila.

NORTHWEST FIXTURE COMPANY

IMPORTERS AND EXPORTERS OF
ALL KINDS OF ELECTRICAL MACHINERY AND SUPPLIES
ELECTRIC, GAS, AND COMBINATION
FIXTURES AND SHADES

313 FIRST AVE. SO. SEATTLE, WASHINGTON | 26 CORTLANDT ST. NEW YORK

R & M Commutator Compound

35 cents per stick **Sample Free**

R & M MANUFACTURING CO.
341 Leland Ave., Chicago

CORLISS ENGINES.

24 x 44 x 48 Allis Cross Compound.
28 x 60 Allis Corliss.
26x48 Fishkill Corliss, R. H.
26x48 Fishkill, L. H.
26x48 Rankin & Fritsch Corliss.
24 x 48 Allis Corliss.
24x42 Rankin & Fritsch Corliss.
20 x 48 Harris Corliss.
20 x 48 Wheelock Corliss.
20x42 Hamilton Corliss.
18 x 42 Wright Corliss.
16 x 42 Harris Corliss.
18x42 Rankin & Fritsch Corliss.
14 x 24 Cooper Corliss.
12 x 36 Harris Corliss.
10 x 30 Allis Corliss.
16x42 Hoffman & Billings Corliss.
20 x 48 Fraser & Chalmers Corliss.

AUTOMATIC ENGINES.

14½ and 24 x 16 Ball & Wood Cross Compound.
13 and 20½ x 15 Armington & Sims Cross Compound.
20 x 24 Erie Class "B" Tangye Bed.
16 x 32 Buckeye.
15 x 14 Ideal.
13 x 18 Porter Allen.
12 x 12 Armington & Sims.
8 x 9 Armington & Sims.

BOILERS.

Six 250-hp. Babcock & Wilcox, 125 lbs.
One 150 Heine, 125 lbs.
Three 72 x 18 Tubulars, 100 lbs.
Twenty 60 x 16 Tubulars, 100 lbs.

W. W. WHITEHEAD COMPANY, Davenport, Iowa.

FOR IMMEDIATE DELIVERY

110-VOLT MOTORS.

1— ¼-H.P. Crocker-Wheeler, type C.
1— 2 " Perett.
1— 2 " Excelsior.
1— 2 " C & C.
1— 3 " C & C.
1— 7½ " General Electric.
1—14 " Billberg.
1—20 " Eddy M.P.
1—35 " Western Electric.

220-VOLT MOTORS.

1— 1 H.P. C & C.
1— 1½ " New England (new).
1— 2 " Diehl, latest style, type H.
1— 3 " Eddy, type C.
2— 3 " C & C.
1— 4 " Sprague Electric.
3— 5 " Diehl, latest style, type H.
1— 5 " G. E., almost new, enclosed.
1— 5 " C & C.
3— 7½ " C & C (new).
2— 7½ " Crocker-Wheeler, type D.
2— 7½ " Diehl, latest style, type H.
1—10 " Eddy, type G., M.P., 950 R. P. M.
1—15 " Lundell, M.P., 630 R.P.M.
1—20 " C & C, type M.
1—25 " C & C, type M.
1—25 " Sprague.
2—35 " Edison.

500-VOLT MOTORS.

1— ½-H.P. Perett.
1— ½ " Towel.
1— 2 " Eddy, type C.

ALTERNATING CURRENT MOTORS.

1— 1-H.P. Westinghouse, 2-phase, 60-cycle, 7200 alternations, 220 volts.
1— 3 " Wagner, type A.C.I., 1-phase, 60-cycle, 7200 alternations, 208 volts.
1— 5 " Westinghouse, 2-phase, 60-cycle, 7200 alternations, 200 volts.
1—10 " Westinghouse, 2-phase, 60 cycle, 200 volts.
1—40 " G. E., 2-phase, 60 cycle, 200 volts.

110-VOLT DYNAMOS.

30-Light Perett, compound wound.
40 " E. G. Benard Co., M.P., compound wound.
50 " Edison, shunt.
75 " Excelsior, rebuilt, practically new.
120 " Edison, compound wound.
200 " Bilberg, compound wound.
300 " Bilberg, compound wound.
320 " Eddy, M.P., type G., compound wound.
400 " Edison, shunt.
600 " Western Electric.
1—300-Light Eddy M.P., type G.
2—400 " Edison, com. wound.

DIRECT-CONNECTED RIGS.

1— 1½-K.W. Riker, B.P., direct-connected to Herreshoff engine.
1— 5 " Riker, M.P., compound wound generator, direct-connected to a No. 4 Case engine.
1—15 " Crescent, M.P., compound wound generator, direct-connected to Armington & Sims engine.

DIRECT-CONNECTED EXHAUST WHEELS.

1—30-inch direct-connected to C & C motor, 110 volts.
1—48 " Wing steam fan.

BOILER AND ENGINE.

10-H.P. Vertical New York Safety Engine.
" Vertical Donnegan & Swift Boiler.

ARC LAMPS.

6—Upton's open arc (brand new).
8—Incandescent Arc Light Company's enclosed lamp.

ARMATURES.

1— 1½-H.P. Lundell (brand new).
1— ½ " Lundell (brand new).
1— ¼ " Lundell (brand new).
1— 1 " Crocker-Wheeler, rewound.
1— 2-H.P. Eddy, type C., 500 volts.
1— 7 K.W., M.P., Sturtevant (brand new).
2—300-light Mather, rewound.
1—30 K.W. Edison, B.P. (brand new).

WRITE FOR SPECIAL PRICE LIST.

D. S. HOLCOMB, 51 Dey St., New York
BUYS OR SELLS all kinds of Electrical Apparatus

TO AVOID MOVING TWICE

We will make especially low prices on the following apparatus for a few days

1—50 K.W. Multi-polar Excelsior 125-volt Generator, direct-connected to a New York Safety Engine, 12x13, practically new.
1—75 K.W., 125-volt multi-polar American Ball Generator, direct connected to an American Ball engine, complete with sub-base, used three months.
1—150 H.P. 16x15 Phoenix engine.
1—300 H.P. 14x24x16 New York Safety Tandem Compound Engine.
1—100 H.P. 13x12 Phoenix Engine.
2—100 K.W., 6-pole, Triumph, 110-volt Generators.
2—50 K.W. Triumph multi-polar, 110-volt Generators.
2—50 K.W. Jenny bi-polar, 110-volt Generators.
2—25 K.W. Jenney bi-polar, 110-volt Generators.
1—250 H.P. Worthington Water Tube Boiler, good for 135 pounds Hartford.
3—100 H.P. 60x18 Phoenix Boiler, good for 95 lbs. Hartford.

Write for Price List No. 43 for other apparatus

ILLINOIS MAINTENANCE COMPANY
E. H. CHENEY, Manager
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BUILD AND REPAIR ALL CLASSES OF ELECTRIC POWER GENERATORS AND MOTORS.

Estimates given on application. All work guaranteed. Complete isolated plants installed.
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We pay the freight one way.

The Miller-Knoblock Electric Mfg. Co.

COMMUTATORS ELECTRO-MAGNETS
ARMATURE COILS WATCH DEMAGNETIZERS
MAGNET WIRE ELECTRICAL REPAIRING

SOUTH BEND, INDIANA

The men with whom you wish to do business are readers of ELECTRICAL WORLD AND ENGINEER.

ELECTRICITY=STEAM

LIGHT AND POWER

IMMEDIATE DELIVERY

DIRECT CONNECTED UNIT.

500-550 VOLTS.

1 M. P. 10-500-125 General Electric, direct connected to a 21 x 42 x 30 Vertical Compound Engine.

SPECIAL.

A New Lot, *absolutely first-class*, G.E. 58 RAILWAY MOTORS. 37 H.P.

RAILWAY GENERATORS. BELTED.

4—300-kw General Electric.
3—375-kw Westinghouse.
3—200-kw General Electric.
1—111-kw Westinghouse.
2—100-kw General Electric.
1—100-kw Edison.
4—75-kw Thomson-Houston.
4—D62 Thomson-Houston.
4—60-kw Edison.

RAILWAY MOTORS.

G. E. 800, S. R. G., 30.
G. E. 1000, W. P., 30.
G. E. 1200, W. P., 50.
Westinghouse, 3.
Westinghouse, 12A.
Westinghouse, 38B. G. E., 58.
K, K2 and K12 G. E. controllers.
Westinghouse 38 and 49 controllers, and a constantly changing stock of everything pertaining to street car equipment.

STREET CARS.

Open and closed, of all sizes, and for all gauges. *Let us know your wants.*

Lot of 8-Bench Stephenson Open Cars, with Brill or Peckham single trucks for 4 ft. 8½ in. gauge.

Lot of 9-Bench Brill Open Cars, with Brill No. 21 trucks.

Lot of St. Louis Closed Cars, 18 ft. 6 in. long, in first-class condition, for standard gauge.

EXTRA ARMATURES.

1—100-kw Edison, 500 volts.
2—60-kw " 500 volts.
2—60-kw " 110 volts.
1—25-kw " 110 volts.
1—15-kw " 110 volts.
2—D62 T.-H. 500 volts.
1—D50 T.-H. 500 volts.
1—A120 T.-H. alternating toothed style.
8—T.-H. M. D. 2-Arc Armatures of the ring type.

DIRECT CONNECTED UNITS.

1 100-kw Westinghouse, 8-pole, 225 r. p. m., direct-connected to McIntosh & Seymour comp. engine, 110 Volts.

BELTED MOTORS. 500 VOLTS.

4—60-kw Edison.
1—50-hp General Electric.
1—25-hp Eddy.
1—12-kw Edison.
1—12-hp Jenney.
1—10-hp Kester.
1—10-hp Mather.
1—9-hp Jenney.
1—7½-hp Thomson-Houston.
1—6-hp Holtzer-Cabot.
1—5-hp Eddy.
2—3-kw Edison.
1—3-hp Eddy.
1—2-hp C & C.
1—1-hp General Electric.
2—½-hp Jenney.
1—¼-hp Lundell.

BELTED DYNAMOS AND MOTORS. 220 VOLTS.

1—75-kw Siemens & Halske.
1—15-hp C & C.
1—15-hp Perret.
1—15-hp Excelsior.
1—10-hp Eddy.
1—10-hp Thomson-Houston.
1—10-hp Lundell.
1—8-hp Excelsior.
1—7½-hp Lundell.
1—3-hp Excelsior.
1—2½-hp Ft. Wayne.
1—15-kw Siemens & Halske, for direct connection.

BELTED DYNAMOS AND MOTORS. 110 VOLTS.

1—100-kw Westinghouse M.P.
1—75-kw Western Electric.
1—50-kw Western Electric.
2—60-kw Edison.
2—45-kw Edison.
3—30-kw Edison.
5—25-kw Edison.
1—20-kw Edison.
1—50-kw Siemens & Halske.
1—45-kw General Electric M.P.
1—25-kw M.P.-6 Excelsior.
1—16-kw Lundell.
1—13½-kw American Ball (new).
2—12½-kw Kester M.P.
1—15-hp Excelsior.
1—15-hp Mather.
1—10-hp M.P. Excelsior.
1—10-hp bipolar Excelsior.
1—10-hp M.P. C & C.
1—6-hp Mather.
1—5-hp Thomson-Houston.
1—125-amp. Westinghouse.
5—1¼-hp M.P. Excelsior.
1—10-amp. Westinghouse.
1—3-kw Mather.
1—21-amp Ft. Wayne.
1—2-hp Excelsior.
1—110-amp. Akron.
1—30-hp U. S.

ALTERNATORS.

1—300-kw Stanley, two-phase, 16,000 alternations, 1100-2200 volts.
1—300-kw Fort Wayne, 2000 volts, 7200 alternations, single-phase.
1—250-kw Westinghouse, two-phase, 2200 volts, 60-cycle.
1—240-kw Stanley, two-phase, 380 r. p. m., with engines direct connected.
1—240-kw Westinghouse, 110 volts, 16,000 alternations, single-phase.
1—210-kw Westinghouse, latest type, single-phase, 7200 alternations, 1100 volts.
3—150-kw General Electric, monocyclic, 1050 volts, 120-cycle, complete.
2—A120 General Electric, single-phase, 1000 volts, 16,000 alternations.
2—120-kw Westinghouse, single-phase, 2000 volts, 16,000 alternations.
1—100-kw Fort Wayne, 2200 volts, 16,000 alternations.
2—90-kw General Electric, single-phase, 1000 volts, 16,000 alternations.
1—75-kw Stanley, 2000-1000 volts, two-phase, 16,000 alternations.
1—70-kw T.-H., self-oiling, 120 cycle, 1050 volts.
4—60-kw General Electric, single-phase, 1100 volts, 16,000 alternations.
1—60-kw Westinghouse, single-phase, 16,000 alternations, 1100 volts.
1—60-kw Stanley, two-phase, 2000-1000 volts, 7200 alternations.
1—45-kw Westinghouse, 2200 volts, 16,000 alternations.
1—45-kw Westinghouse, 1100 volts, 16,000 alternations.
2—A-35 General Electric, single-phase, 16,000 alternations, 1050 volts.
2—A-30 General Electric, single-phase, 16,000 alternations, 1050 volts.

ARC DYNAMOS.

2—165-light, multi-circuit Brush, 1200 candle-power.
2—125-light, multi-circuit Brush, 2000 candle-power.
3—120-light, multi-circuit Brush, 1200 candle-power.
2—80-light, single-circuit Brush, 2000 candle-power.
2—125-light, latest type Fort Wayne, 2000 candle-power.
2—125-light, brand new Excelsior, 2000 candle-power.
4—M. D. 2, 50-light, Thomson-Houston arc dynamos.
4—L. D. 12, 50-light, Thomson-Houston arc dynamos.
4—M. 2, 45-light, Thomson-Houston arc dynamos.
4—No. 8, 65-light, 2000 candle-power Brush.

ENGINES.

Look over our list of ENGINES which is constantly changing.

1—26 and 48x60 cross compound, Geo. H. Corliss condensing engine, with band wheel 30 ft. in diameter by 72-in. face; complete with jet condenser.
1—36x72 Greene Wheelock engine.
1—34x60 Geo. H. Corliss rolling mill engine, with 40-ton wheel and 17-in. diameter shaft.
2—30x60 Harris Corliss engines with band wheels; speed, 62 r. p. m.
1—29x72 Greene Wheelock engine.
1—24x48 Bates Corliss.
2—16x42 Bates Corliss.
1—10x24 Harris Corliss.
1—18½x18 centre crank Ideal engine, speed 220 r. p. m.; driving wheel 7 ft. 6-in. diameter by 25-in. face.
3—18x34x28 vertical cross compound engines, speed 120 r. p. m.; wheel 60-in. face between cylinders.
1—16½ and 25x15 cross compound Armington & Sims condensing engines, with No. 4 Davison jet condensers.
2—16x16 Erie Ball.
1—14x13 Armington & Sims.
2—13x14 Watertown.
2—12x12 Erie Ball.
1—8x13x8 Westinghouse.

BOILERS.

2—375-hp Sterling boilers, 150 lbs. pressure.
3—250-hp B. & W. boilers.
2—200-hp National water tube.
3—66x16 Return Tubulars, in one battery.
2—500-hp Hazleton vertical boilers.

WE ARE THE LARGEST DEALERS IN SECOND-HAND ELECTRICAL AND STEAM-MACHINERY IN THE WORLD. IF YOU ARE IN WANT OF ANYTHING IN THIS LINE, WRITE US WHETHER YOU SEE IT IN THIS LIST OR NOT

ROSSITER, MAC GOVERN & CO.

141 BROADWAY, NEW YORK CITY

Factory, JERSEY CITY, N. J. Send for Catalogue

FOR SALE

One battery, seven boilers, horizontal tubular shell 72 inches diameter by 18 feet long; containing 72 tubes, 4 inches diameter each. The shell is ⅜-inch steel with longitudinal seam, butt jointed, double riveted. The heads are 9-16-inch steel, well stayed. The boiler has a manhole in front head and a manhole on top. The bottom at the back is reinforced on top with 2-inch blow-out.

Murphy Patented Smokeless Furnace; grate area 6 feet x 6½ feet with front, and with automatic stoker and magazine 6 feet x 2½ feet x 1½ feet; grate bars, shaking pattern, and ash-pit doors complete. Castings for setting and tie rods and buck staves with boiler. Each boiler has a 6-inch pipe for connecting to a steam main equipped with a Pratt & Cady globe valve, also blow-off valves and Ashton pop safety valve and Reliance water column.

With battery is a 4-inch main with branches for cooling grates with exhaust steam with all fittings complete, also blow-off and feed-water mains on back of boilers. The valves of the branches of the feed-water mains may be operated on front of boilers by means of rods. Battery has two double duplicate stoker engines, one at each end, with all connections complete for operating stokers.

The entire battery is in first-class order and has the equipment for running condition, including smoke breeching. It was built by the Variety Iron Works in 1892 and has been worked with as much as 125 pounds steam pressure.

Purchaser to visit our Power-House and make price. Material will be placed on board cars free of charge to purchaser.

The Cleveland Electric Railway Co.
CLEVELAND, OHIO.

FOR SALE.

(No reasonable offer refused.)

One Armington & Sims Engine, 14 in. diameter, 13 in. stroke, with pulleys 66 in. diameter by 15½ in. face.

One Deane Independent Condenser, 12 in. x16x18, 300-hp.

One piece 5⅞ in. shafting, 18 ft. 6 in. long, with companion flanges one end.

Three floor hangers, with self oil boxes, for 5⅞ in. shaft, 39 in. drop and adjustable all round.

Three granite capstones for hangers.

Two friction clutch pulleys, 66 in. dia. by 18½ in. face, 36 in. friction with wheel, collar, toggles and shoes complete.

One clamp iron pulley, 66 in. dia., 10½ ace to clamp on 8½ in. quill.

One bracket quill for floor hanger mentioned above.

One clamp iron pulley, 44 in. dia., 8½ in. face for 5½ in. shaft.

One clamp iron pulley, 44 in. dia., 5½ in. face for 5½ in. shaft.

One clamp iron pulley, 44 in. dia., 5½ in. base, 8½ in. bore.

One A 12 T. H. alternating current generator.

125 cycles—1000 volts—60 amperes.

Wooden base in operative condition.

All the above goods are for immediate delivery and f. o. b. cars Newton or Watertown, Mass.

For delivery about September 15th we have:

One A 120 T.-H. alternating current generator. 125 cycles—1000 volts—100 amperes, compound wound with iron base.

One A 12 T.-H. alternating current generator. 125 cycles—1000 volts—60 amperes with wooden base.

One 60-kw Stanley transformer step up. 125 cycles, 1000 volts to 2000 volts.

Seven Station switchboard G. E. transformers, 125 cycles, 350 watts, 1040 to 52-104 volts.

One 5-kw Exciter, T.-H., 110 volts.

ELECTRICAL DEPARTMENT, NEWTON & WATERTOWN GAS LIGHT CO., NEWTON, MASS.

You can increase the efficiency of your advertising by sending us NEW CUTS frequently.

Cream Flux

An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS. Contains no Acid or Any Element Injurious to Electrical Connections. **We Guarantee it, and if not Satisfactory, Money will be Refunded.** You can make more than double the number of perfect connections in one half the time with CREAM FLUX than you can with the same amount of any other flux.

PUT UP IN CANS AT 15c, 25c, 45c, and 75c

SEND FOR TRIAL BOX SPECIAL PRICES IN QUANTITY

THIS IS WHAT ONE USER HAS TO SAY: "After having tried the various soldering salts on the market, and after giving your **CREAM FLUX** severe tests on heavy cable connections, and on the finest stranded flexible drop cord work, we can safely say it meets all claims you make for it. I consider it one of the best ever offered for sale. Yours truly, CHICAGO EDISON CO., Per J. H. GORAST, Constr. Supt."

Endorsed by the National Board of Fire Underwriters and all users

FOR SALE BY ALL SUPPLY HOUSES OR

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REPAIR SHOPS.

78 MARKET STREET CHICAGO. TELEPHONE, MAIN 1280.

First-Class Equipment in all Shops.

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Dynamos, Armatures, Motors, Arc Lamps, Instruments, Machine Shop Engines, Etc., Carpenter Shops; Cabinets, Etc.

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SECOND-HAND Dynamos and Motors.

WE INVITE CORRESPONDENCE WITH THOSE WISHING TO BUY OR SELL.

SCHUREMAN & HAYDEN,
137 S. Clinton St., Chicago.

WANTED AND FOR SALE

All kinds of second-hand

Testing Instruments

RALPH VOSE,
25 Sunnyside St., Hyde Park, MASS.

FOR SALE.

A well established electric light plant in a rapidly growing town of 2500 or 3000 inhabitants in State of Minnesota. Address E. L. P., care Electrical World and Engineer, New York.

WANTED

Three 100-light, second-hand Brush arc machines and two second-hand large high frequency alternators. Address D. G. C., care Electrical World and Engineer, New York.

WANTED.

One second-hand, 160-light, brush, multi-circuit, 9 6-10 amperes, arc machine. Address DELAWARE ELECTRIC LIGHT, HEAT & POWER CO., Delaware, Ohio.

FOR SALE

SECOND HAND NATIONAL ALTERNATOR

Alternator and Exciter, self-contained, surface wound, not compounded, 133-1000 volts, 30 amp., 30 k w., self-oiling bearings, speed 1500 rev. per minute

No. 514 TYPE PAPER PULLEY

SUB BASE AND JACK SCREW IN GOOD CONDITION

Address
FREDERICKTOWN E. & MFG. CO.
FREDERICKTOWN, MO.

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A MONTH.

NEW YORK TELEPHONE CO.
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FOR SALE.

Lot 10-volt New Fan Motors at bargain prices. Old material purchased.

WALSH'S SONS & CO.,
Newark, N. J.

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BADT-GOLTZ ENGINEERING CO.
1504 Monadnock Block, CHICAGO.
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"But you've gathered in riches galore,
"Pray how did you do it, and was it hard work,
"And can it be done any more?"

"In the days of my youth," father William replied,
"Though I learned every trick of my trade,
"Until I had learned the great secret of all,
"My clothing was shabby and frayed."

"What was that great secret?" the young man cried,
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"To make money, you must advertise."

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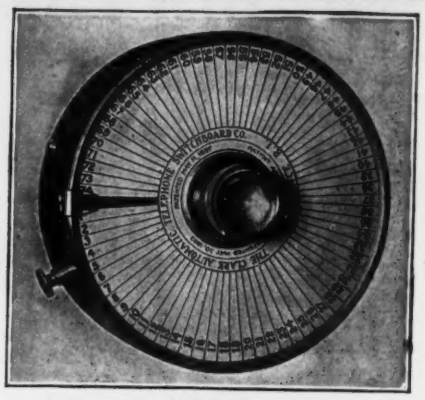

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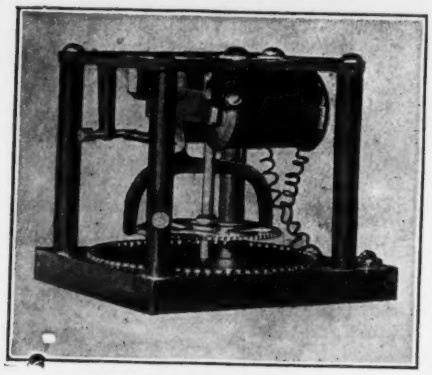

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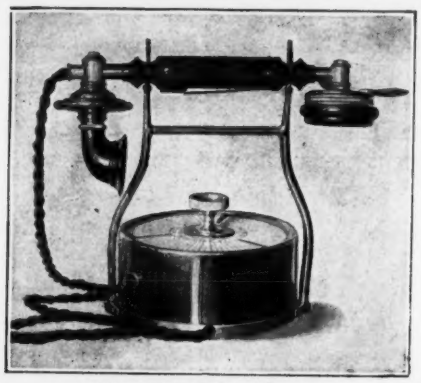

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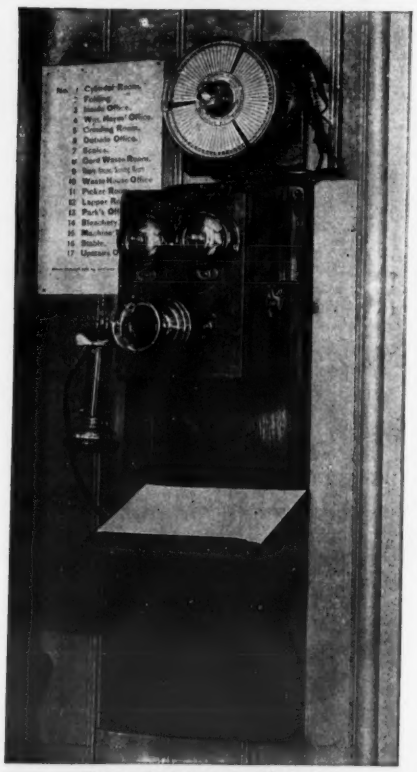

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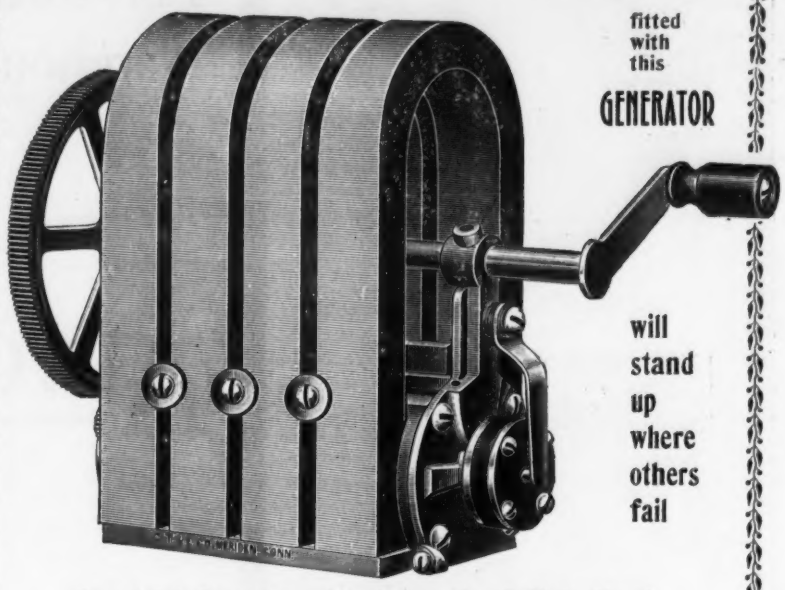

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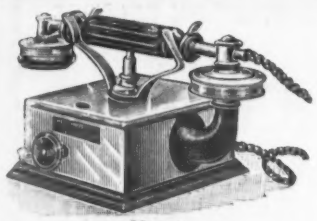

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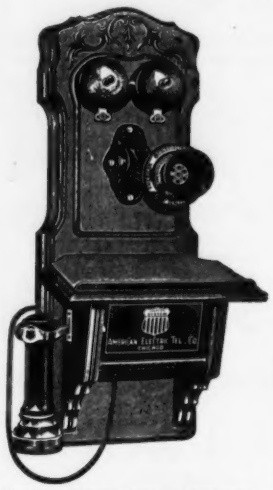

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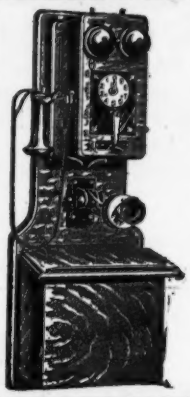

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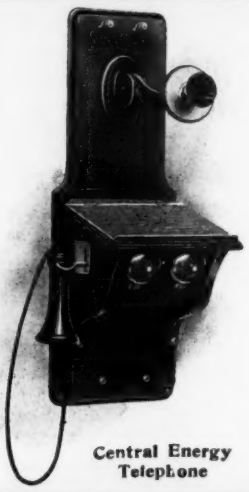

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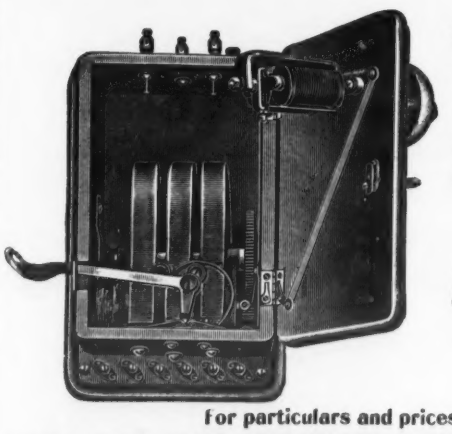

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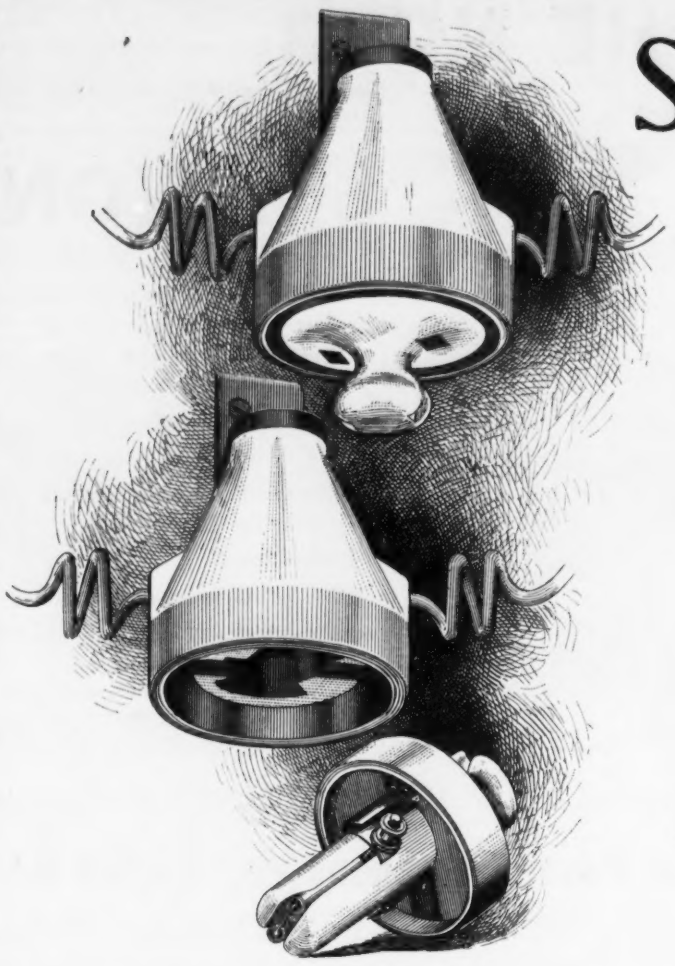

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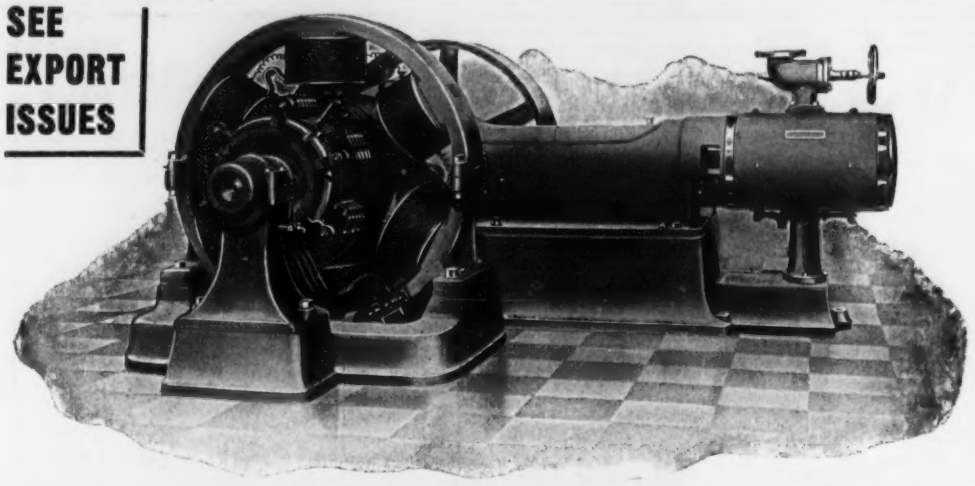

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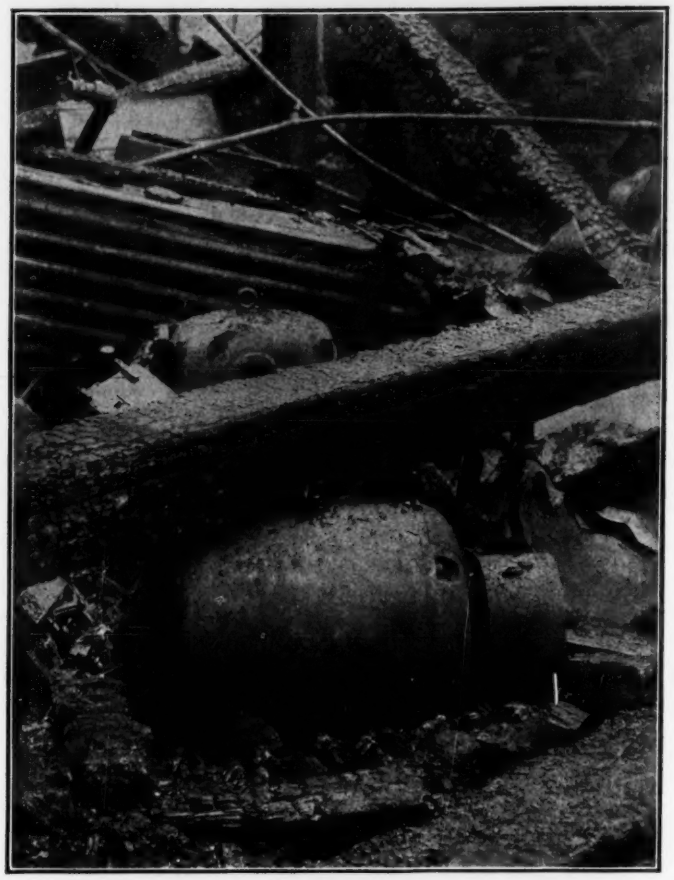

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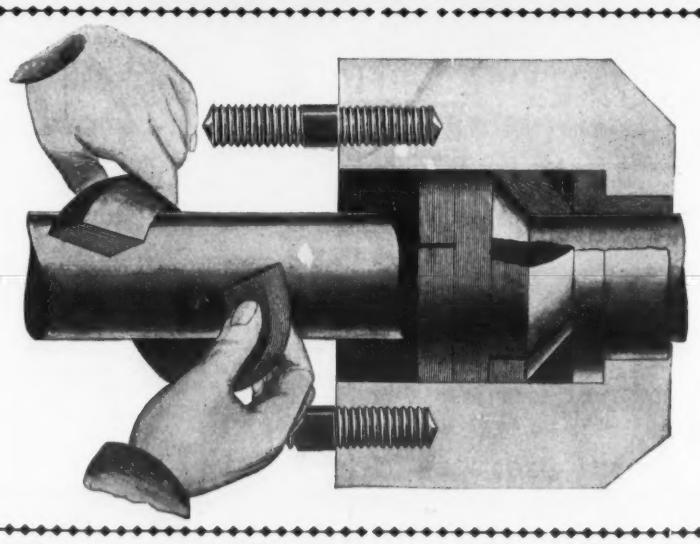
NEW YORK OFFICE:
120 Liberty Street.



"GALVANIC" METALLIC STUFFING BOX PACKING

PATENTED

IS THE SIMPLEST AND MOST DURABLE METALLIC PACKING OBTAINABLE.

"Galvanic" Metallic Packing does not burn or melt; it never cuts or injures the rod.
"Galvanic" Metallic Packing is flexible, can be applied and removed easily, needs very little oil and attention.
"Galvanic" Metallic Packing holds absolutely steam, (also superheated), air, water and ammonia.
"Galvanic" Metallic Packing has long life, reasonable price and gives entire satisfaction.

FOR PARTICULARS AND FREE SAMPLES WRITE TO

CALVANIC METAL PAPER CO.,

18-20 MORRIS ST., JERSEY CITY, N. J.

OUR "CALVANIC" METAL DYNAMO BRUSHES ARE UNEXCELLED.

AGENTS FOR ALL DISTRICTS OF THE U. S. WANTED FOR BOTH ARTICLES.

ONONDAGA DYNAMOS AND MOTORS

ON FLOOR,
SIDE WALL OR CEILING

Our "Type E" Enclosed Power Motors are faithful, steady power producers which will yield you long service and absolute satisfaction. We build carefully, and Onondaga machines require few repairs.

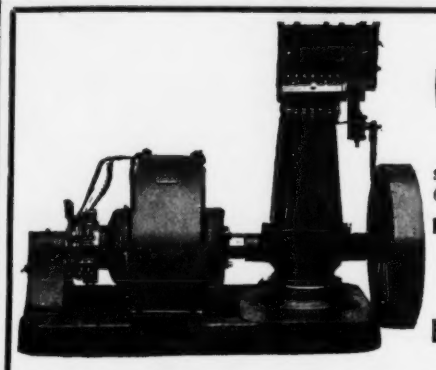
ONONDAGA DYNAMO CO., SYRACUSE, N. Y.

New York Office: 220 Broadway. New England Agent: E. C. Crocker, Bridgeport, Conn.
St. Louis Agents: Laufketter & Bendit, 810 Oliver Street. (2)

CLING-SURFACE makes all sorts of belts in all sorts of positions stop slipping, run easy, carry more load and doubles their lives.

Try it. Pay only if O. K.

CLING-SURFACE MFG. CO.
144-150 Virginia St.
BUFFALO, N. Y. [3]



DIRECT-CONNECTED
GENERATORS
FROM 30 LIGHTS UP.

Our 30-light unit occupies a floor space of only 22″×36″. Weight 650 lbs. Speed 500 r. p. m.

EFFICIENT, ECONOMICAL,
RELIABLE, COMPACT.
Correspondence Invited.

ENGBERG'S
Electrical and Mechanical Works,
ST. JOSEPH, MICH.

Commutator Polishing

Carborundum Paper is revolutionizing the old methods.

One sheet of Caborundum Paper does the work of ten to twenty sheets of sand paper, and, at the same time, does it very much faster and cleaner.

Carborundum cuts off the high spots; sand paper rides over them.

It is a non-conductor—it is fast-cutting—it is long-lasting.

Let us send you a sample sheet to prove all these things.

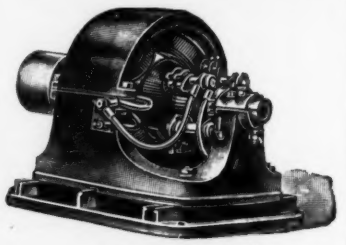
The Carborundum Company
NIAGARA, FALLS, N. Y.

JENNEY DYNAMOS AND MOTORS

ARE STRICTLY HIGH GRADE.

JENNEY ELECTRIC MFG. CO., ... Indianapolis, Ind.

HIGH GRADE, SLOW SPEED
DYNAMOS AND MOTORS



OUR TYPE G.
23 to 200 Kilowatt
THE NEW ENGLAND MOTOR CO.
LOWELL, MASS.

TACHOMETERS

PORTABLE TYPE.

They are made in stationary and portable form for speeds up to 3,000 rev. per minute, and are superior to any other instruments made for the same purpose. Manufactured exclusively by

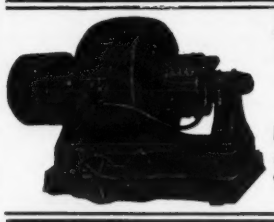
SCHÄFFER & BUDENBERG
BROOKLYN, N. Y.
SALESROOMS:
No. 66 John St., New York.
No. 15 West Lake St., Chicago, Ill.

"PALMER & OLSON"
1, 2, 3, 5, 7½, 10 H. P.

GOSSIP!

It is generally conceded that for compactness, durability, highest efficiency, simplicity, noislessness, detailed mechanical and electrical perfection and graceful design, our motors and dynamos have no equal.

PALMER & OLSON,
MANUFACTURERS
210 Centre St. New York



Jantz & Leist Electric Co.
MULTIPOLAR MOTORS AND DYNAMOS
808–810 ELM ST.
CINCINNATI, O. U. S. A.

Bullock Electric Mfg. Co.
CINCINNATI, U. S. A.

Wagner Electric Mfg. Co.
ST. LOUIS, U. S. A.

Direct and Alternating Current Equipments for Electric Light and Power. (287)

In Electrical World and Engineer the weekly Digest of Current Technical Electrical Literature gives a complete resume of current progress in electrical science and its application, both in this country and abroad.

The men with whom you wish to do business are readers of ELECTRICAL WORLD AND ENGINEER.

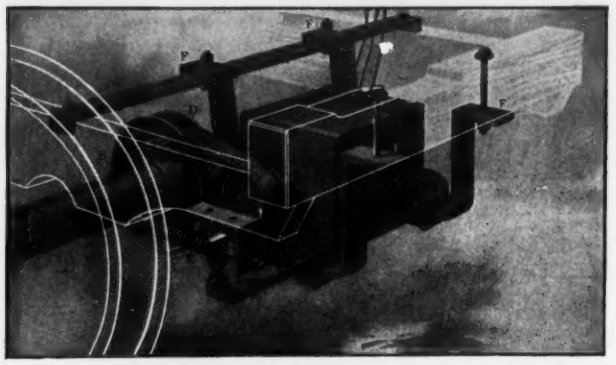
If you do not know who makes what you want to buy, consult the advertising pages of ELECTRICAL WORLD AND ENGINEER.

Electric Lights and Fans

FOR RAILWAY PASSENGER CARS

Electricity generated from Car Axle while car is in motion, and supplied from storage battery when car is stationary. The "Axle Light" equipment is automatic in its operation. Each car carries its own lighting apparatus.

WRITE FOR ILLUSTRATED CATALOGUE



GENERATOR APPLIED TO CAR TRUCK.
A, Dynamo; B, Driving Pulley on Axle; C, Armature Pulley; D, Flexible Gearing, E, Tension Spring; FFFF, Hangers.

CONSOLIDATED RAILWAY ELECTRIC LIGHTING AND EQUIPMENT COMPANY

100 Broadway, New York

W. M. Abbott
Vice-Pres. and Gen. Mgr.

J. L. WATSON, Sec. and Treas.,
JNO. T. DICKINSON, General Agent.
519 Rookery, Chicago.

STURTEVANT BLOWERS

ENGINES
MOTORS
GENERATING SETS
FORGES
STEAM HEATING APPARATUS

·196·

B·F·STURTEVANT·Co

BOSTON·MASS·U·S·A

NEW YORK ♀ PHILADELPHIA ♀ CHICAGO ♀ LONDON

You can increase the efficiency of your advertising by sending us NEW CUTS frequently.

CROCKER-WHEELER CO. MAIN OFFICE AND WORKS, AMPERE, N. J
MANUFACTURERS DIRECT CURRENT MOTORS AND DYNAMOS
AGENTS IN ALL PRINCIPAL CITIES.
Write for descriptive Bulletins

GENERATORS ELWELL-PARKER ELECTRIC CO. OF AMERICA MANUFACTURERS GUARANTEES QUALITY CLEVELAND, OHIO. MOTORS

LATEST IMPROVED TYPE

MOTORS AND DYNAMOS

THREE RIVERS ELECTRIC CO.

OAK STREET, - - THREE RIVERS, MICH.

DYNAMOS AND MOTORS

We make bipolar, multipolar and alternating current dynamos and motors; also motors for horseless carriages, cranes, elevators, plating dynamos and rotary transformers.

Send for illustrated catalogue, with price list. A written guarantee with each machine.

2½ H.P. Horseless Carriage and Crane Motor. Weight, 147 lbs.

THE LINCOLN ELECTRIC CO., 71 Ontario Street, CLEVELAND, OHIO.

Agents for New York and vicinity, also for Export, Kenny Electrical Mfg. Co., Park Row Bldg., N. Y. City. Cable Address, Kemaco, New York. (3)
Agent for Washington and Oregon, O. H. Pierson, Elma, Wash.

THE APPLE DUPLEX STORAGE BATTERY

FOUR VOLTS

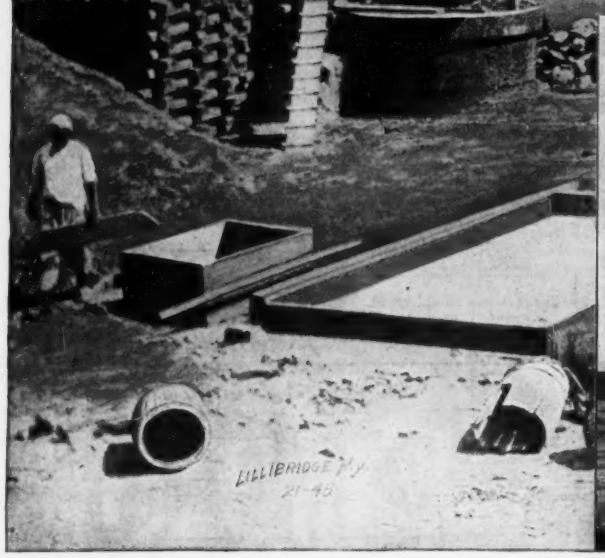
and not a joint in the entire battery.

Storage Batteries for any purpose.

Gas Engine Igniting Dynamos, Magnetos, and everything pertaining to economical gas engine ignition.

THE DAYTON ELECT. MFG. CO.,
DAYTON, O.

The men with whom you wish to do business are readers of ELECTRICAL WORLD AND ENGINEER.



THE engraving, made from photographs, illustrates the famous **ATBARA BRIDGE** built by the American Bridge Company, Pencoyd Plant, in 1899, for the British Government.

The expedition with which this work was accomplished and delivery effected, has been the talk of engineers the world over, and had influences of international consequence.

The Bridge consisted of seven (7) spans, weight of whole being 756 tons.

Quotation was made January 20th, 1899, and order received January 24th. Although three (3) days were wasted by wrong data, shop drawings were started January 31st, and completed and material all ordered ten (10) days later.

On March 7th, one month from the day of the actual beginning of work, the entire structure was shipped from Pencoyd. This notwithstanding a blizzard which closed down the shop for seven (7) days. Only forty days (**twenty-nine actual working days**) **elapsed from receipt of final data to date of shipment.**

The erection crew left New York April 22d, in the employ of the British government, and arrived at Atbara on June 16. A little over two months later the bridge was complete, including additional work equivalent to the erection of two extra spans.

American Bridge Company

GENERAL OFFICES 100 BROADWAY NEW YORK

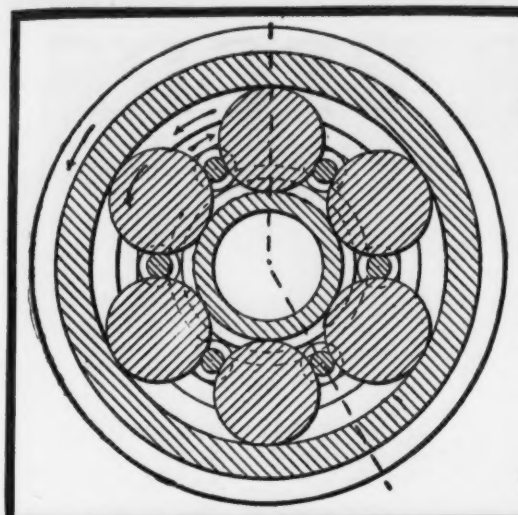
LILLIBRIDGE, N. Y., 21-95

ENGINEERS, MANUFACTURERS and CONTRACTORS for

STEEL BRIDGES, STEEL BUILDINGS & Metallic Structures

of Every Description.

Branch Offices Throughout the Country.
European Office: LONDON.



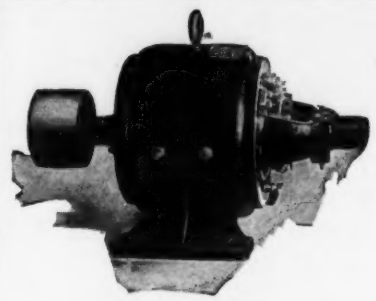
The "A. R. B." Roller Bearing

For Motors, Car Axles, Automobiles, Shafting, Sheaves, Etc.

This cut shows the principle involved. Future advertisements will show application.

AMERICAN ROLLER BEARING CO
BOSTON, MASS.

Western Dept.: K. Franklin Peterson, 165 Lake St., Chicago.



1 H. P. MOTOR.

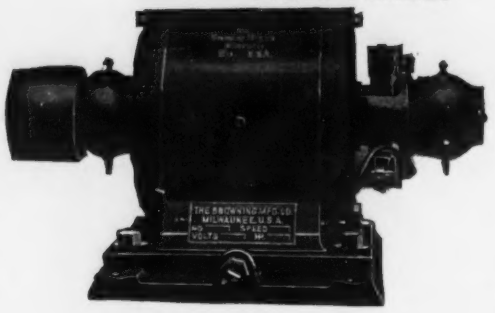
Our
PROTECTED TYPE
Dynamos and Motors
can be relied upon for good work.

We make a limited line of sizes, but as good as we can. Our Prices are Right, too.

THE ROBBINS & MYERS CO.
Springfield, O.

HIGH GRADE MOTORS AND DYNAMOS

PROTECTED TYPE, SPHERICAL STEEL FRAMES



From 1-4 H. P. to 3½ H. P.

We make Motors as small as 1-12 H. P.

SEND FOR BULLETINS

THE BROWNING MFG. CO.
MILWAUKEE, U. S. A.

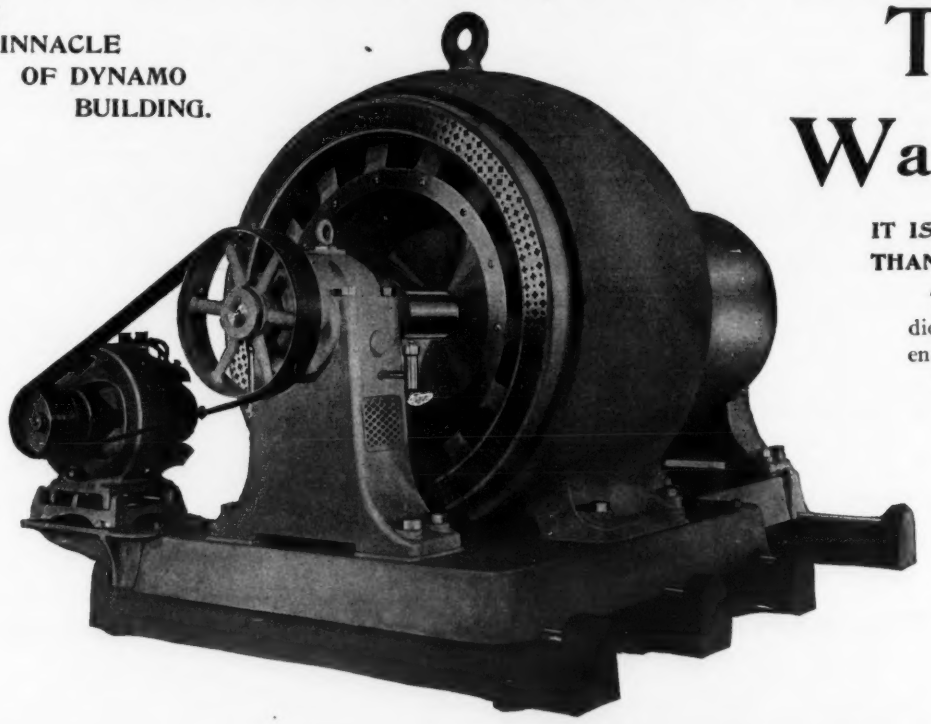
New York Office: 321 Havemeyer Bldg. M. E. Baird, Eastern Manager.
Chicago Office: 1804-1812 Fisher Bldg. Kohler Bros., Agents.
Minneapolis Office: 329 Hennepin Avenue, Gugler Electric Manufacturing Co.
Southwestern Agents: Western Electric Supply Co., St. Louis, Mo.
New England Agents: Chase-Shawmut Co., Boston, Mass.

AARON ELECTRIC CO.

...MANUFACTURERS OF....
MULTIPOLAR DYNAMOS AND MOTORS
141 SOUTH CLINTON STREET
TELEPHONE MAIN, 469 CHICAGO, ILL., U. S. A.
WATCH EXPORT ISSUES

You can increase the efficiency of your advertising by sending us NEW CUTS frequently.

THE PINNACLE OF DYNAMO BUILDING.



The Improved Warren Alternator

IT IS EASIER TO INVENT COMPLICATIONS THAN TO PRESERVE PRACTICAL SIMPLICITY.

The designers of the Warren Alternator have studiously avoided intricate, delicate and costly parts, endeavoring in every way to preserve simplicity, reliability, durability, efficiency and ease of management.

The absence of moving wire, collector rings, commutator and brushes makes the Warren peculiarly well fitted for the exacting conditions of long, continuous service.

No attention required except the occasional refilling of oil reservoirs.

WARREN ELECTRIC MF'G. CO.
SANDUSKY, OHIO.

RUMSEY ELECTRICAL MF'RS CO., 1217 Filbert St., Philadelphia.
H. B. WARREN, Sandy Hill, N. Y., for Northern and Western New York and New England States.
WESTERN ELECTRICAL SUPPLY CO., St. Louis, Mo.
NORTHWEST ELECTRICAL ENGINEERING CO., Portland, Ore.
IRON CITY ENGINEERING CO., 410 Penn Ave., Pittsburg, Pa.
C. W. HOBSON, Waco, Tex.
H. B. COHO, 149 Broadway, New York.
SMITH-COURTNEY CO., Richmond, Va.
THOS. MUIR & SON, Detroit, Mich.
J. HOLT GATES & CO., 13-15 Monadnock Blk., Chicago.
JOHNSON LAW CO., Jacksonville, Fla.

TYPE "M. P." **C & C GENERATORS**

for direct-connection to high-speed engines are made in standard sizes, ranging from

25 K-W. TO 150 K-W.

They are, in every sense and detail, strictly up-to-date machines, and are built for hard, steady service, with liberal overload margin.

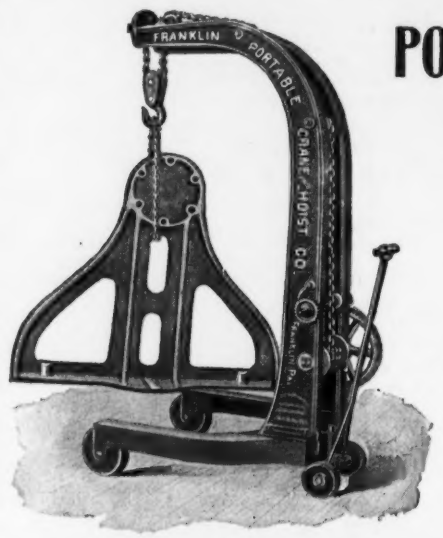
The C & C Electric Co.

Main Office: 143 Liberty St., New York

SALES OFFICES:

BOSTON—10 High St.
CHICAGO—Monadnock Blk.
PHILADELPHIA—45 N. 7th St.
LONDON—47 Victoria St., Westminster.

Works: Garwood, N. J.



PORTABLE CRANE AND HOIST

FOR THE CONVENIENT AND QUICK HOISTING AND TRANSPORTING OF MACHINERY OF ANY SHAPE OR WEIGHT UP TO THREE TONS.....

The handle is rigid in the axle, and when raised against the arms, the weight of the machine rests on the wheels and axle, forming a powerful and perfect brake. Write for circular.

The Franklin Portable Crane & Hoist Co., Franklin, Pa.

THE FOREST CITY ELECTRIC CO.

MANUFACTURERS OF

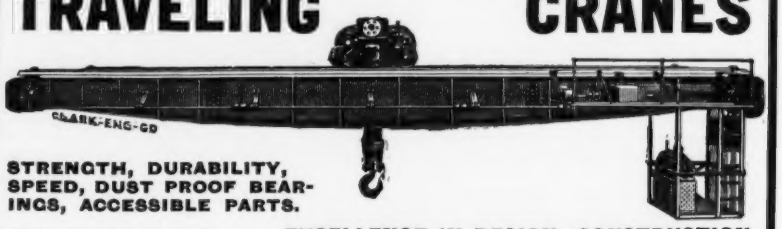
Roll Drop and Drop Forged Commutator Bars

PROTECTED RAIL BONDS

Catalogues and prices on application CLEVELAND, OHIO, U. S. A.

See advertisement in Export Issue

TRAVELING CRANES



STRENGTH, DURABILITY, SPEED, DUST PROOF BEARINGS, ACCESSIBLE PARTS.

Write for Catalogue "B."

BRANCH OFFICES:
NEW YORK, Bowling Green Bldg.
PITTSBURGH, Fidelity Bldg.
CHICAGO, Monadnock Bldg.

EXCELLENCE IN DESIGN, CONSTRUCTION AND OPERATING QUALITIES.

PAWLING & HARNISCHFEGER

Main Office & Works, 163 Clinton St., Milwaukee, Wis.

"COAL HANDLING" OUR NEW ILLUSTRATED BOOK SENT ON APPLICATION. ROBINS CONVEYING BELT CO. 15 PARK ROW, NEW YORK

You can increase the efficiency of your advertising by sending us NEW CUTS frequently.

H. N. FENNER, President. J. F. BLAUVELT, Agent. RUSSELL W. KNIGHT, Treasurer.

NEW ENGLAND BUTT COMPANY,

MANUFACTURERS OF

Machinery for Insulating Electrical Wires.

Braiding, Taping, Winding, Twinning, Cabling, Stranding, Polishing and Measuring Machines. Cable Covering Braiders.

FINE CASTINGS A SPECIALTY.

304 Pearl Street, · · PROVIDENCE, R. I., U. S. A.

United Telpherage Co.

20-22 Broad St., NEW YORK, U. S. A.

Automatic transportation of material by electricity.

Send for Circulars Nos. 11, 12, 14

COAL HANDLING MACHINERY

of many varieties for hoisting Coal, Ore and Stone from vessels, from the simple Mast and Gaff hoisting from canal boats to the most elaborate plant that will unload the largest vessel in one day; Automatic and Cable Railways, Coal Tubs, Steam Shovels, Mast and Gaff Fittings, Wheelbarrows and Hoisting Blocks for both Wire and Manila Rope.

C. W. HUNT CO., Taylor St., W. New Brighton, N. Y.

An intending purchaser of electrical apparatus anywhere always consults this paper's advertising pages to ascertain who makes what he wants. ELECTRICAL WORLD AND ENGINEER is recognized in every country of the world as the leading electrical journal.

JOHN A. MEAD MFG. CO.,

Coal Handling Machinery,

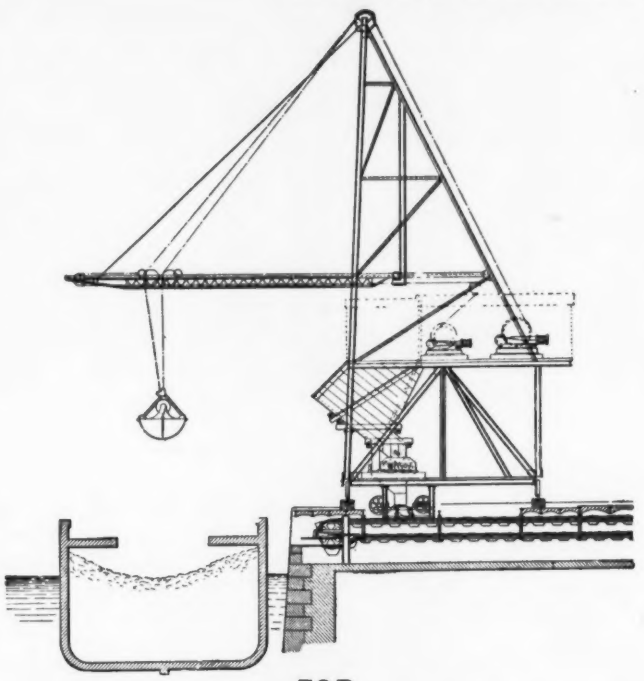
11 GREENWICH ST.,
NEW YORK CITY.

Cut shows lower line of McCaslin Overlapping Gravity Bucket Conveyor installed at the new Power Station of the Milwaukee Electric Railway and Lighting Co. This conveyor receives coal from our patent Automatic Bucket, and delivers to bunkers above boilers. It also removes ashes as shown in cut, and delivers to elevated Ash Bunker. The conveyor is filled by ordinary chutes, the overlapping buckets requiring no Cumbersome Filler.

Send for catalog of Conveyors, Automatic Buckets, Cable Roads, Automatic Roads, etc., etc.

PATENT AUTOMATIC BUCKET.

ELEVATING CONVEYING MACHINERY



FOR

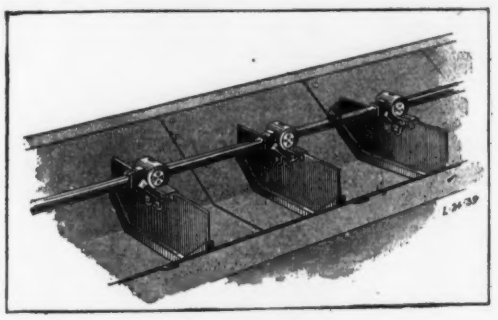
POWER HOUSES, COAL YARDS AND MINES

THE EXETER MACHINE WORKS

Write for new Catalogue "C"

PITTSTON, PA. [1]

New York Office, 15 Cortlandt Street.



The Monobar

for conveying and elevating purposes is superior in all points of excellence to any chain or equivalent device in present use, and this judgment has been endorsed by its record in heavy work.

"Modern Methods" Catalog gives prominence to the Monobar.

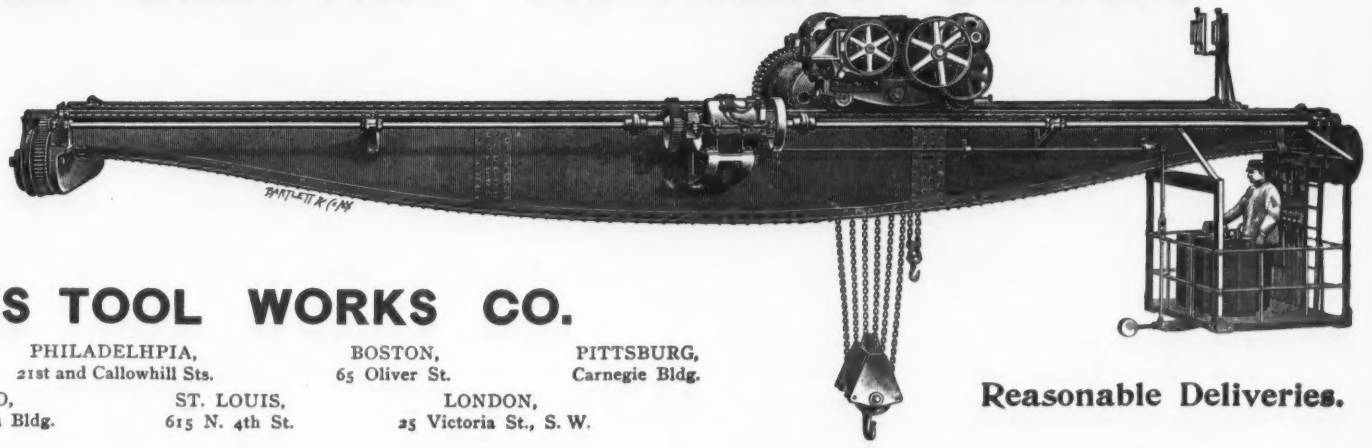
Link-Belt Engineering Co.
NICETOWN, PHILA.

New York: 49 Dey Street
Pittsburg: Park Building
Chicago. Link-Belt Machinery Co.

NILES' ELECTRIC TRAVELING CRANES

Built on Latest and Improved Designs.

For Full Information and Specifications Apply to

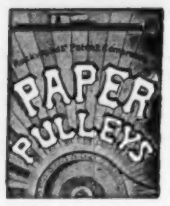


NILES TOOL WORKS CO.

NEW YORK, 136-138 Liberty St.
PHILADELHPIA, 21st and Callowhill Sts.
BOSTON, 65 Oliver St.
PITTSBURG, Carnegie Bldg.
CHICAGO, Western Union Bldg.
ST. LOUIS, 615 N. 4th St.
LONDON, 25 Victoria St., S. W.

Reasonable Deliveries.

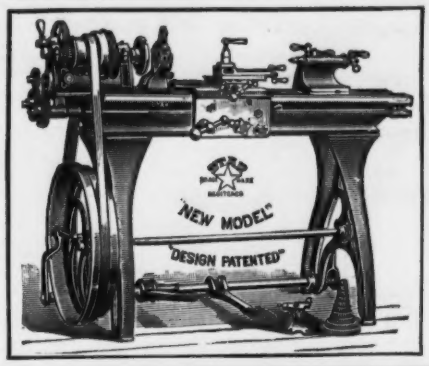
ROCKWOODS' PATENT COMPRESSED PAPER PULLEYS



Should be specified on all contracts and orders for belted apparatus.

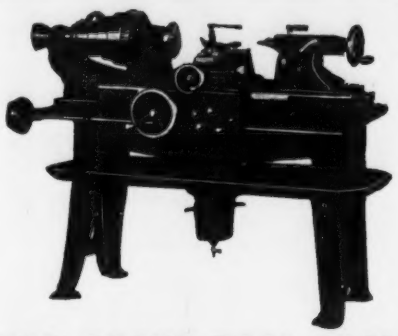
THE ROCKWOOD MANUFACTURING COMPANY

P. O. BOX 462 (E.) INDIANAPOLIS, INDIANA, U. S. A.



Why "STAR" LATHES are Better than Most Lathes

Our 9 and 11 inch "STAR" Foot and Power Lathes are built upon the principle of the **best machine possible** for a fair price. **Note these points:** End-Thrust Ball Bearing Spindle, reducing friction 75 per cent; Reversible Friction Feeds; Adjustable Tool Post Collar and Shoe; Reverse Motion in Head; Foot Power with a Walking Motion **SENECA FALLS MFG. CO.** 422 Water St. Seneca Falls, N. Y.
Send for Catalogue "B."



Hand Lathes, Milling Machines, Upright Drills. Positive Taper Stud and Bolt Lathes, Automatic Worm-Wheel Cutting Machines, Heavy Turret Chucking and Turning Machines.

Money Savers every one of them. They are time-savers.

Get our catalog—it's worth reading. (3)

THE GRANT TOOL COMPANY, Cleveland, Ohio

Want Some Tool Information?

All kinds of Electricians' and Machinists' Tools—right up to the minute—are correctly described, explained and illustrated in the new and revised edition of

MONTGOMERY & CO.'S TOOL CATALOGUE

A veritable Tool Encyclopedia, fully indexed. Full of solid and useful information from cover to cover. A complete education about Tools of all kinds. Free by mail for 25 cents. (1)

MONTGOMERY & CO., 105 Fulton St., New York City.

BOOKS

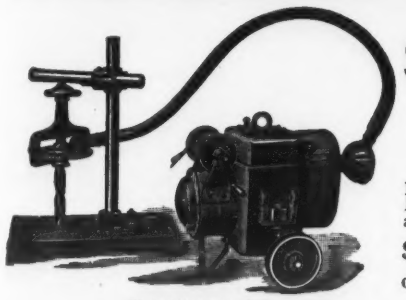
ON ANY ELECTRICAL SUBJECT sent, prepaid, to any address in the world, upon receipt of price.

Send for Catalogue.

ELECTRICAL WORLD AND ENGINEER, 120 Liberty Street, N. Y.

REG TRADE MARKS
"Phosphor-Bronze"
DELTA

THE PHOSPHOR BRONZE SMELTING CO. LIMITED.
2200 WASHINGTON AVE., PHILADELPHIA.
"ELEPHANT BRAND PHOSPHOR-BRONZE"
INGOTS, CASTINGS, WIRE RODS, SHEETS, ETC.
—DELTA METAL—
CASTINGS, STAMPINGS AND FORGINGS.
ORIGINAL AND SOLE MAKERS IN THE U.S.



COMBINATION OF

STOW FLEXIBLE SHAFT

AND

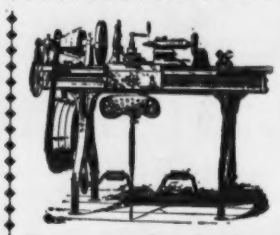
Iron Multi-Speed Motor.

Practically dust and water proof. For Portable Drilling, Tapping, Reaming, Emery Grinding, etc. Write for Catalogue and prices.

STOW MFG. CO., Binghamton, N. Y.

General European Agents, SELIG, SONNENTHAL & CO., 85 Queen Victoria Street, London, England.
SEE STATIONARY MOTORS IN NEXT ISSUE.

Established 1875.



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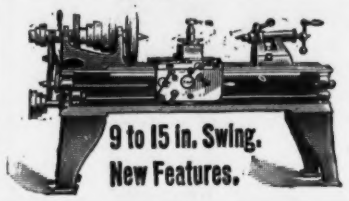

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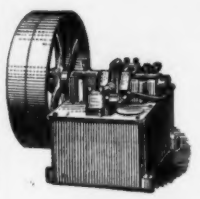

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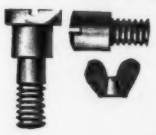

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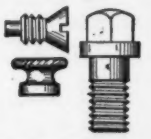

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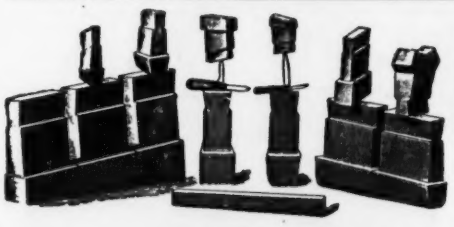

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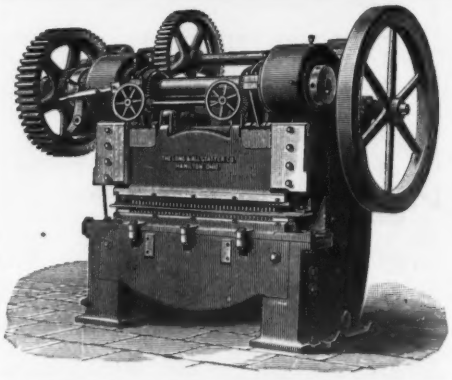

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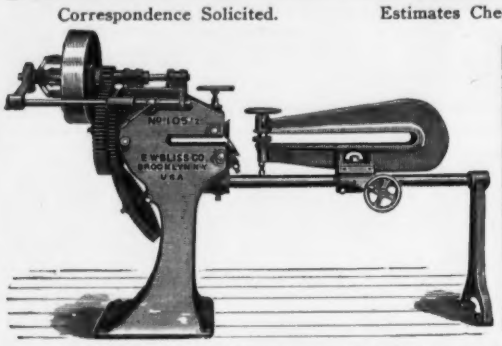

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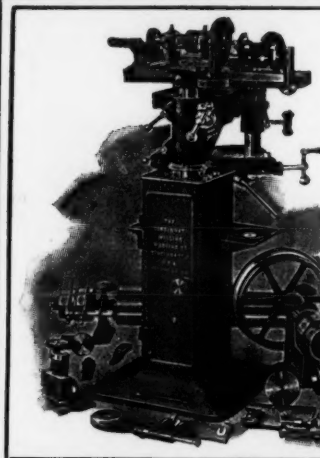

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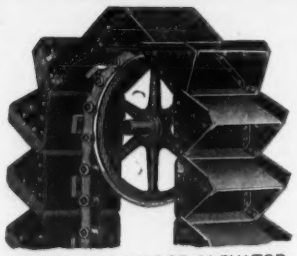

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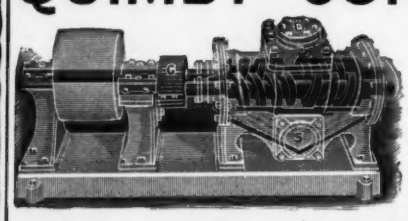

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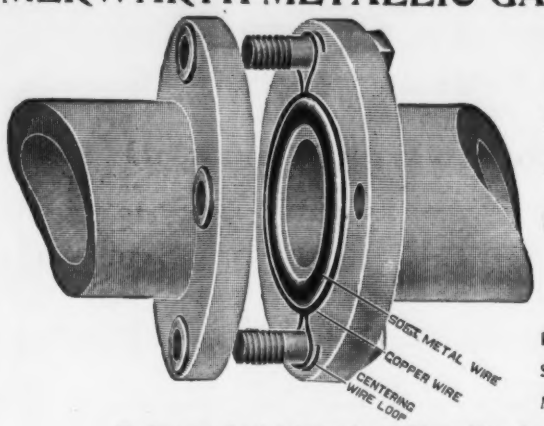

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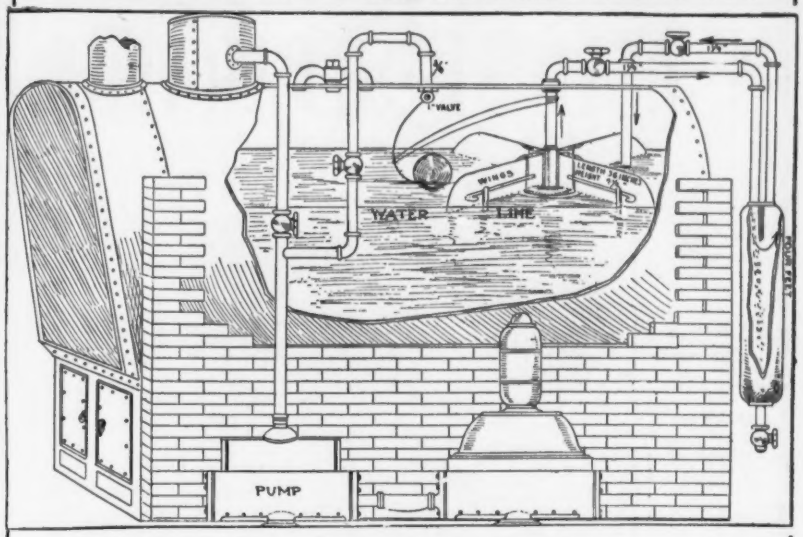

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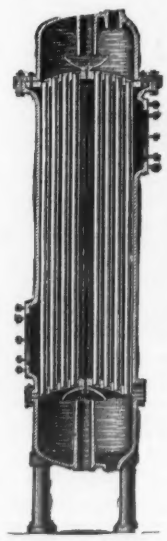

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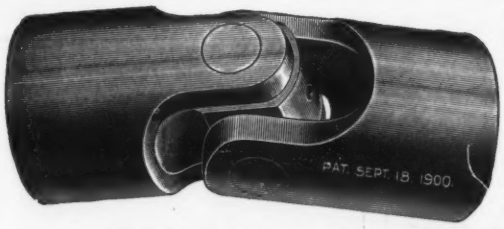

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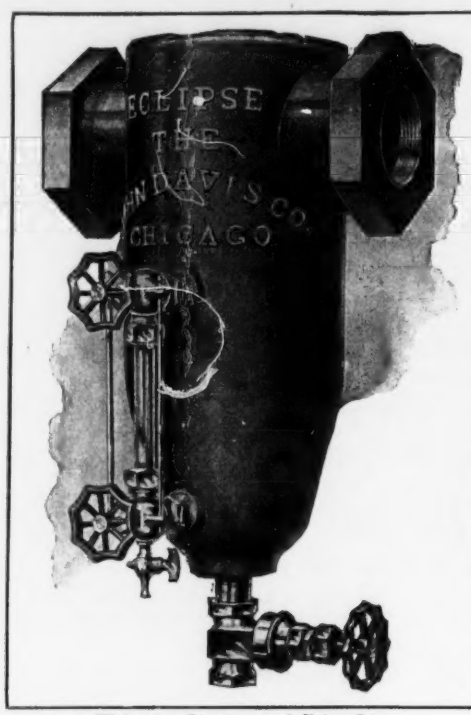

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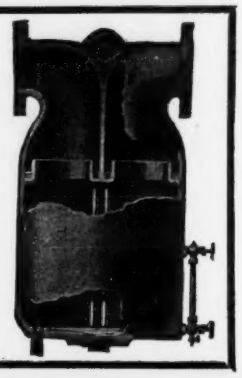

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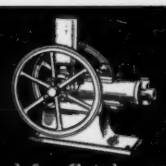

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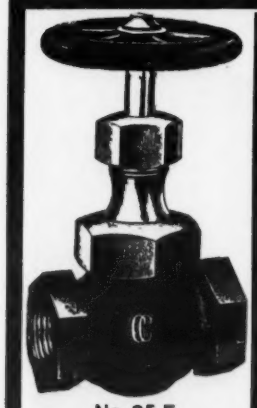

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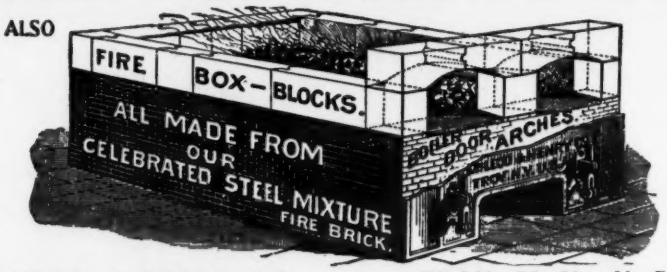

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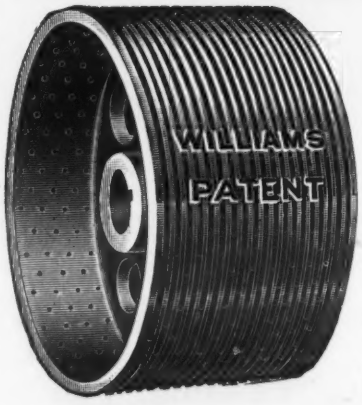

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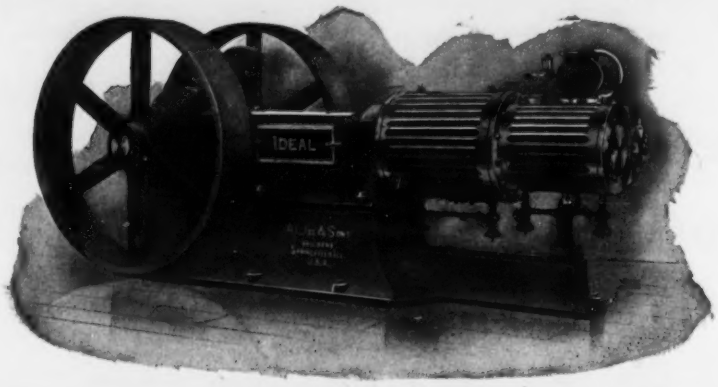

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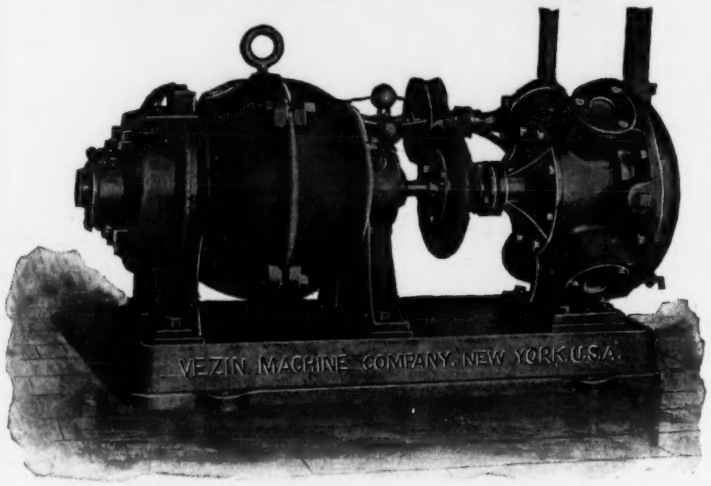

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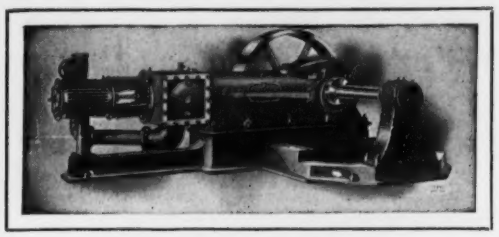

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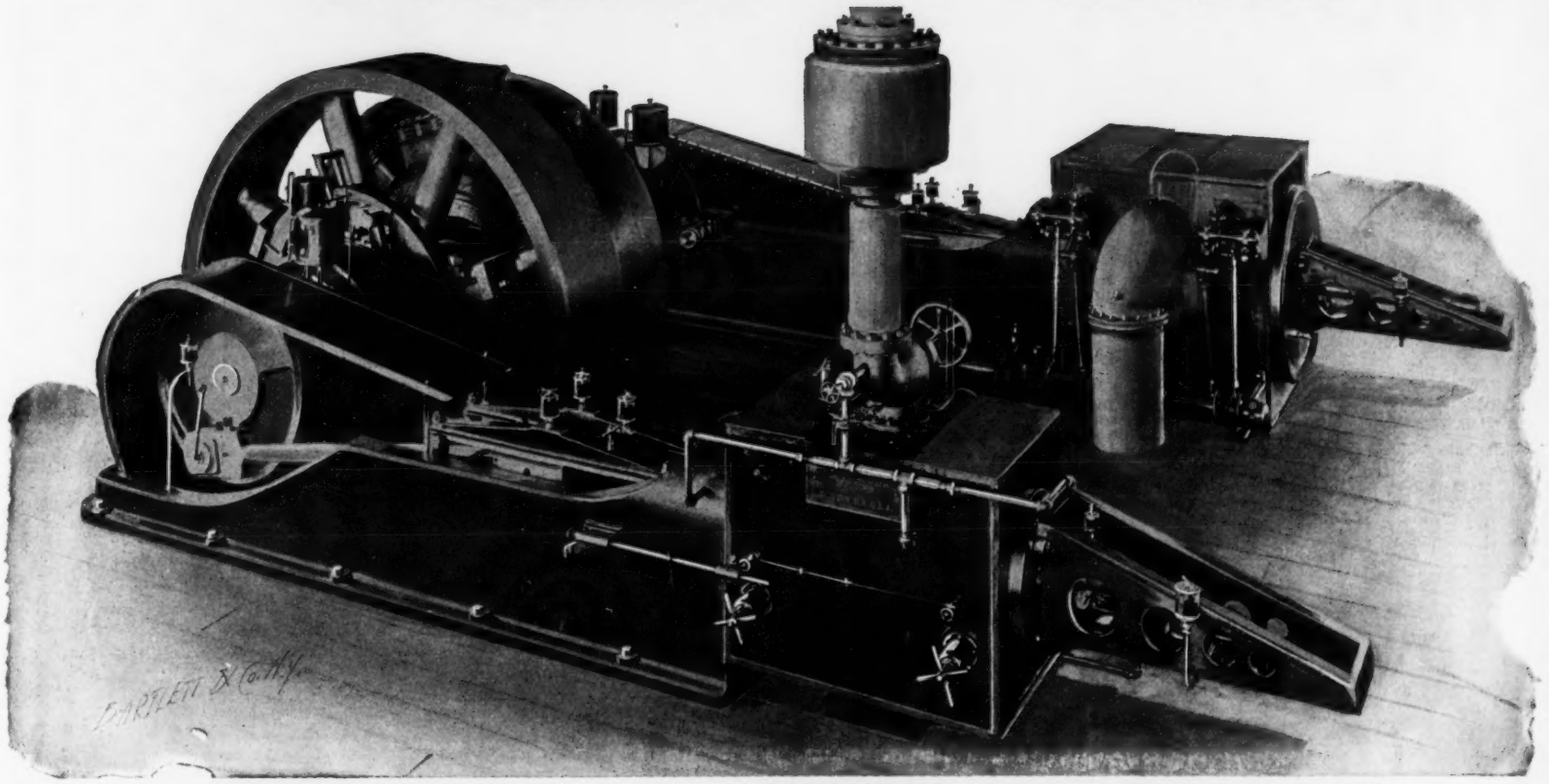

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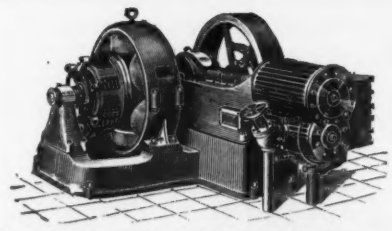

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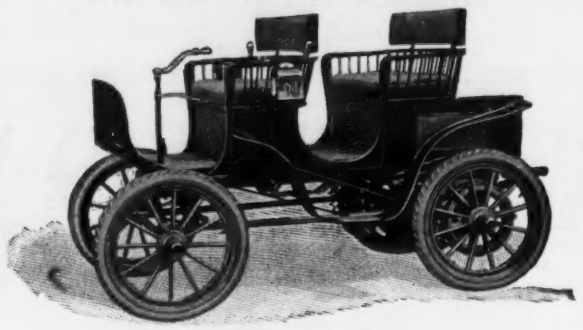

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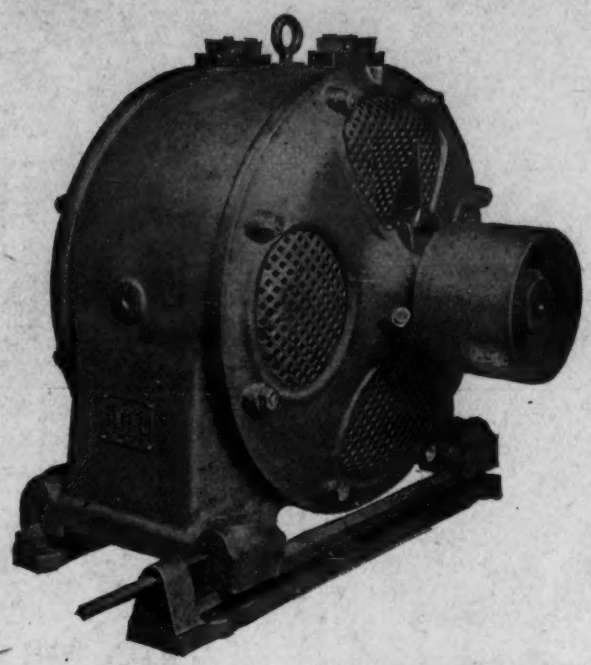

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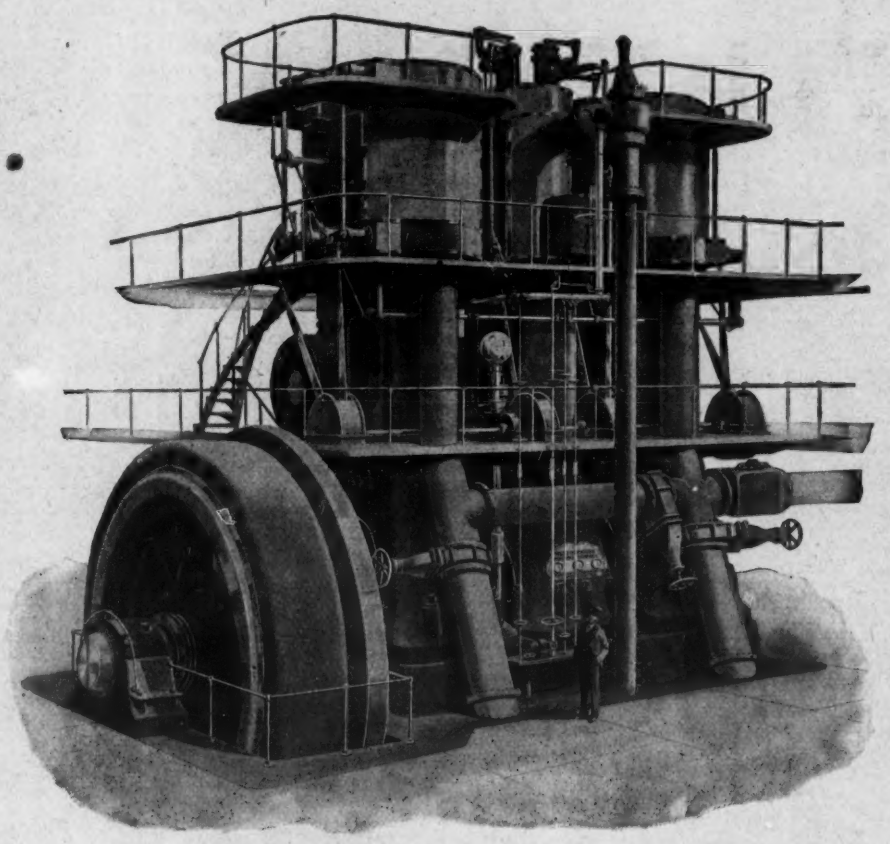

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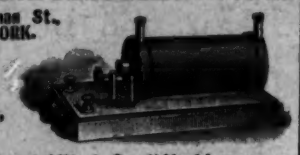

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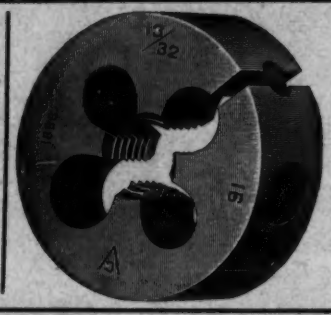

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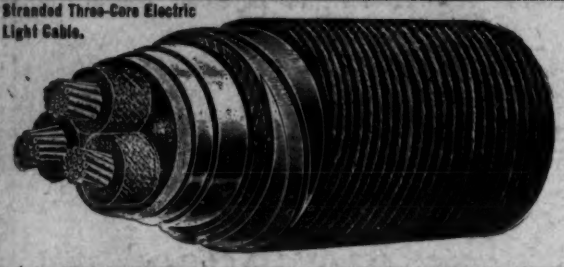

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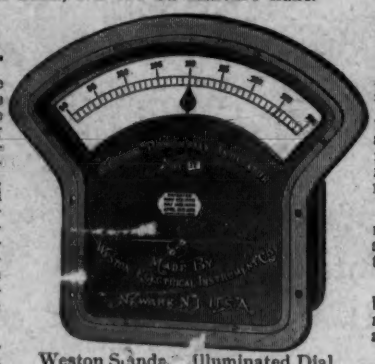

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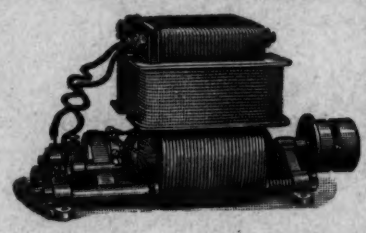

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